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OPERATIONAL FEASIBILITY TEST (OFT) OF
XM9, SIMULATOR PROJECTILE, AIRBURST, LIQUID (SPAL)

Samuel E. Jackson, Jr.

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U. S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The objective of this test was to estimate the operational effectiveness of the XM9 Simulator, Projectile, Airburst, Liquid (SPAL) as a chemical defense training system in conjunction with the proposed US training doctrine. Information to estimate the system mission performance, training, and doctrine for use was collected. Limited information to estimate system reliability, availability and maintainability (RAM) was also collected.		

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September 1978

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CONTENTS

INTRODUCTION	3
METHOD AND PROCEDURES	5
FINDINGS	9
CONCLUSIONS	11
APPENDIXES	
A. OFT Issues	13
B. Summary of Pre-OFT NBC Proficiency Test Results	16
C. OFT Protocol	19
D. Trial Operations Orders	28
E. Trial Synopses	38
F. Trial Plots	58
G. Attack Plots	64
H. Umpire's Observations	71
I. Observations On Decontamination Performance	77
J. Estimate of SPAL Reliability in OFT	86
FIGURES	
1. Simulator, Projectile, Airburst, Liquid L1A1 (SPAL) Parts	4
2. Operating Principle (SPAL)	6

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OPERATIONAL FEASIBILITY TEST (OFT) OF XM9, SIMULATOR PROJECTILE, AIRBURST, LIQUID (SPAL)

INTRODUCTION

Purpose

The objective of this test was to develop information to estimate the operational effectiveness of the XM9 Simulator Projectile, Airburst, Liquid (SPAL) as a chemical defense training system in conjunction with the proposed US training doctrine.

Background

The requirement for effective simulant chemical agents and simulant agent disseminator systems to aid in chemical defensive training was first identified in World War I. In 1972, the authority to use live agents in training was rescinded creating a training void and an urgent requirement for a realistic simulant-filled dissemination system to train individuals and units to survive on the chemical battlefield. A US Army Training and Doctrine Command/US Army Materiel Development and Readiness Command (TRADOC/DARCOM) Joint Working Group (JWG) was formed in 1973 with the responsibility of directing the required development program. In September 1975, a Proposed Statement of Work for a Training System for Chemical Defense was issued by the JWG in response to this requirement.¹

Currently a developmental program is under way at Chemical Systems Laboratory (CSL), US Army Armament Research and Development Command (ARRADCOM), Aberdeen Proving Ground, MD, to meet the requirements identified in the statement of work. Type classification of the total system is expected by 1983. In the interim, however, a suitable chemical defense training system is needed by the US Army. The JWG proposed the US adopt a modification of the United Kingdom (UK) Simulator, Projectile, Airburst, Liquid, L1A1 (SPAL) Training System which could be quickly evaluated and type classified. This proposal was approved by TRADOC which issued a Training Device Letter Requirement (TDLR) for the modified UK training system in March 1977 as Phase I of the Training System for Chemical Defense.²

Description of Materiel

SPAL is a United Kingdom chemical defense training system proposed for adoption by the US for training of US forces. It consists of a 1 liter polyethylene bottle containing a liquid agent simulant and a propellant/burster charge, and a 30 centimeter long cardboard launch tube with a sheet metal base and ground implanting stake (Figure 1). The propellant charge is fired

¹Letter, ATSI-CTD-MS-C, USAOC&S, 26 September 1975, subject: Proposed Statement of Work for a Training System for Chemical Defense.

²Letter, ATTSC-TD-RDS, USATRADOC, 31 March 1977, subject: Training Device Letter Requirement (TDLR) for the Training System for Chemical Defense Phase I.

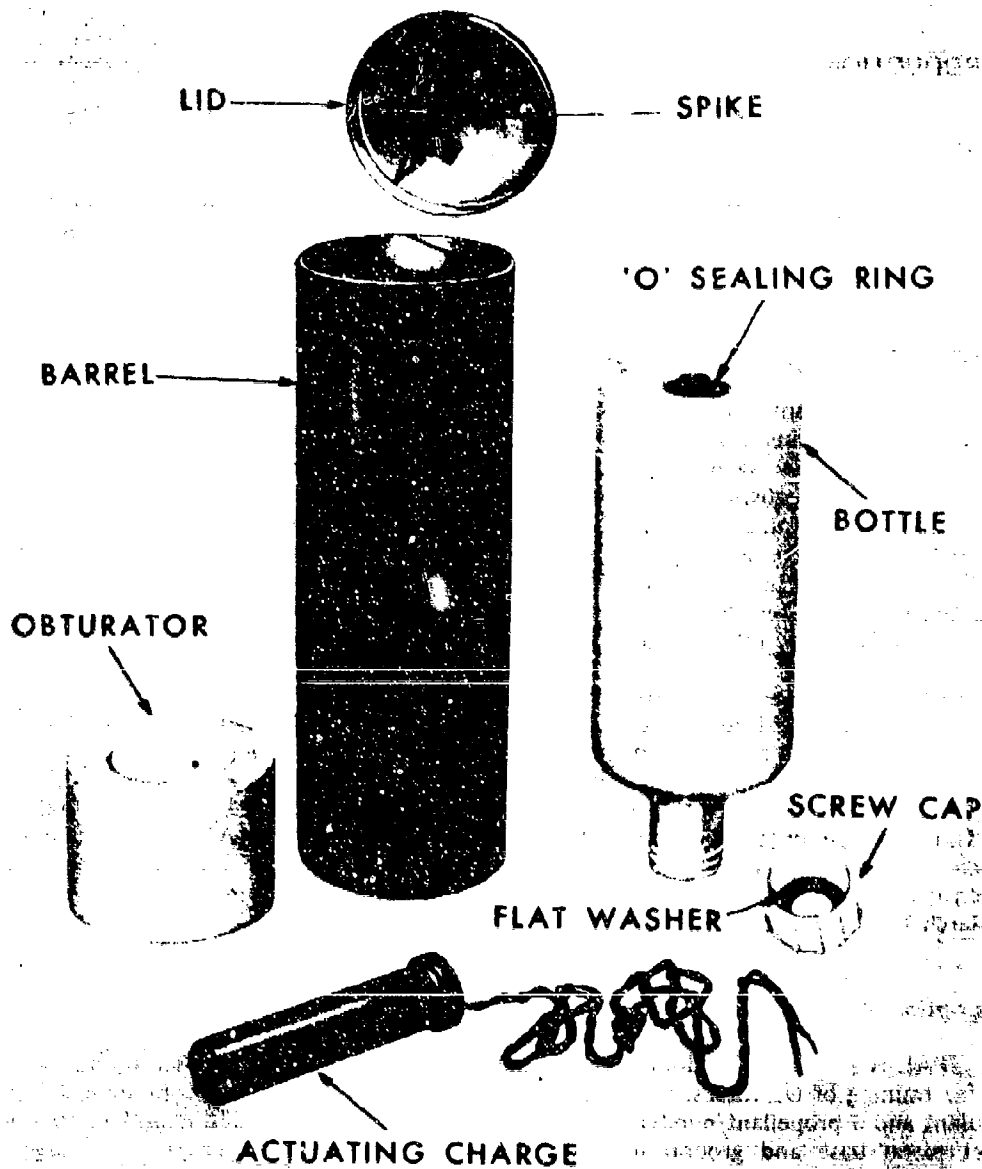


Figure 1. Simulator, projectile, airburst, liquid L1A1 (SPAL) parts.

electrically, projecting the bottle vertically from the ground implanted launch tube to a height of about 12 meters. Upon airburst at this height, the simulant agent is disseminated as droplets which fall to the ground, downwind from the point of burst over an area approximately 10 meters wide by 50 to 100 meters long (Figure 2).

SPAL components are assembled by the user and, normally, SPAL is used in multiples in a network to obtain satisfactory area coverage for squad size training exercises. Typically a line of five SPAL, spaced at 10-meter intervals, will be used for small-unit training.

For US use, SPAL is to be filled with Chemical Agent, Simulant Training 1 (CAST 1), a mixture of Polyethylene Glycol 200 (PEG-200), 90 parts by weight, and water, 10 parts by weight, as the persistent agent simulant, rather than Chemical Agent Training Mixture 2 (CATM 2) which is used by the UK. Two of the ingredients in CATM 2 are not acceptable to the US from a medical point of view. The Office of the Surgeon General approved CAST 1 for the Army-wide use in October 1976.

Scope

The XM9 SPAL OFT was conducted during the week of 12 September 1977 at the Range Area of Aberdeen Proving Ground (APG), MD. The test consisted of training and limited tactical exercises. Information to estimate the system mission performance, training, and doctrine for use was collected. Limited information to estimate system reliability, availability, and maintainability (RAM) was also collected.

Basis for Comparison

Since the XM9 SPAL is a unique system for which no standardized counterpart currently exists, the sole basis for assessment were the operational issues identified for the test in the Independent Evaluation Plan (IEP) for Phase I of the Training System for Chemical Defense.³ The sources for all IEP issues are the Statement of Work and TDLR for Phase I. The operational issues extracted from the IEP that were addressed in the OFT are identified in Appendix A.

METHOD AND PROCEDURES

Test Squad

The soldiers who comprised the test squad were from the 82d Airborne Division, Ft. Bragg, NC. All had the duty MOS 11B; three had combat experience.

Uniform/Equipment Configuration

The test squad wore the temperate zone duty uniform, Suit, Chemical Protective (Overgarment), CB protective gloves and the M1 helmet. They carried, and used, the M17A1

³Independent Evaluation Plan (IEP) for Phase I of the Training System for Chemical Defense, Jan 77 (Incl 2) to Ltr, ATSL-CD-OR, USAOC&S, 25 Jun 77, subject: Request for Waiver of Operational Test II (OT II) of the Phase I of the Training System for Chemical Defense.

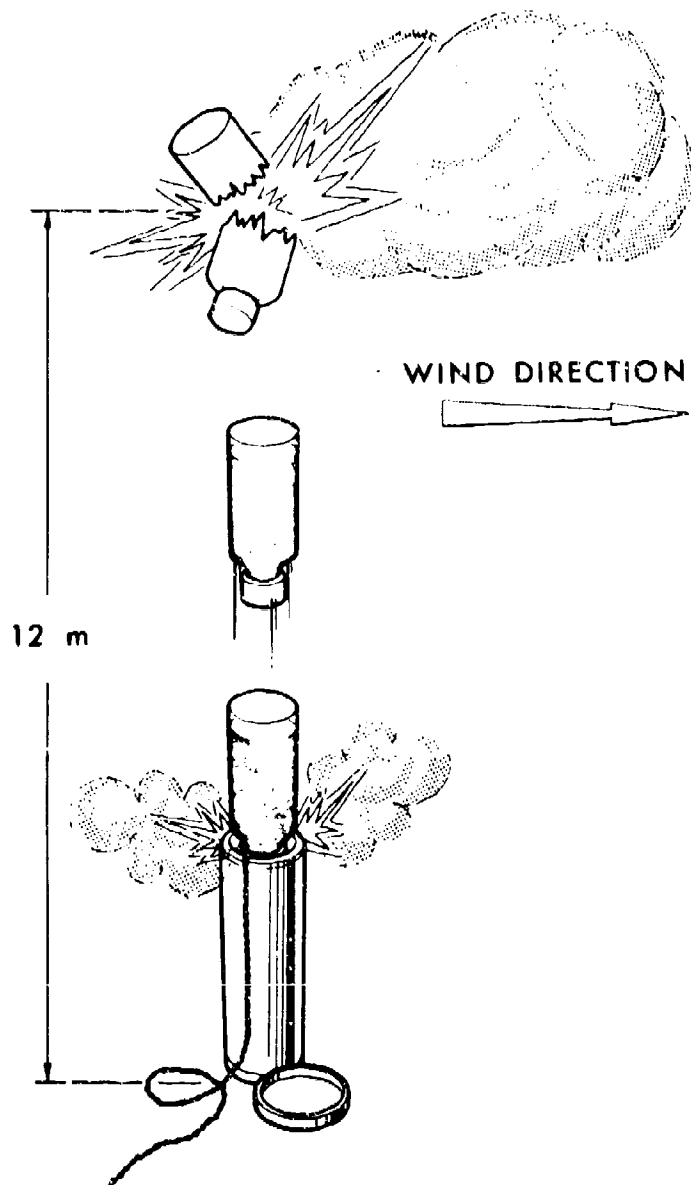


Figure 2. Operating principle (SPAL).

protective mask with hood, M58 Decontamination Training Aid, M13 Decontamination and Reimpregnating Kit, and the M256 Chemical Agent Detector Kit. They also wore bands of XM9 Detector Paper on those parts of the body specified by the currently proposed use doctrine (arm at biceps, wrist, and just above the boot). These detector bands were replaced after each SPAL attack. The test soldiers carried a light assault load (M16 rifle, combat pack, webbing, ammunition, etc.). The radio telephone operator (RTO) was equipped with a field radio. On Test Day 1, the test squad wore industrial-type safety goggles as an additional safety precaution. However, at the end of the day it was decided the goggles were unnecessary and were interfering with the performance of the troops. Thus, the goggles were not worn on succeeding test days.

Training

Since the test squad was composed of MOS-qualified soldiers, it was assumed that they possessed a minimal knowledge of basic chemical defensive actions needed to survive a chemical attack and the subsequent contamination hazard. Training for the OFT was therefore limited to a two-hour review of individual CB defensive techniques. This included a review of the use of skin and equipment decontamination kits, proper masking procedures, and the capabilities and use of detection equipment and methods. Training was conducted by an officer and NCO (both CmlC) who used the chemical defense materiel as training aids. A short test was given prior to the training to grossly estimate the test unit's level of proficiency. The test questions and results are summarized in Appendix B.

Test Site Selection and Preparation

1. The OFT Protocol, Appendix C, contains the planning guidelines for the test which was to be conducted at the Edgewood Area of APG.

2. In March 1977, two officers attached to the US Army Ordnance and Chemical Center and School (OCCS) (one CmlC, one Armor) selected M, N, and G Field areas of Edgewood Area for the conduct of the OFT. These officers formulated tactical scenarios and selected sites for six squad actions. Each action involved movement of the squad from an Assembly Area (AA) to an objective. Movement routes were to be dictated by (a) terrain features, such as swampy ground, etc., (b) tactical ruses, such as contaminated and mined area; and (c) specific instructions given to the squad in Operations Orders (OO) preceding the actions. Each route, with possible SPAL positions, was sketched on an area map.

3. When representatives of OCCS, HEL, and CSL visited the test sites in May 1977, they found the vegetation so dense that one of the original six routes was no longer suitable for the emplacement of SPAL. However, this route could be used with artillery simulators and/or other harassment by aggressor forces to create the threat of chemical attack.

4. Final preparation of the five sites was made in August 1977. At that time an exercise Control Point (CP) was selected for each route which would provide an overview of the entire route. Primary and alternate SPAL firing positions for each route were sketched out, surveyed and plotted on area maps to aid in monitoring from the CP during the exercise. Positions for gas and mine markers, which were used to channel the squad to and through SPAL-targeted areas, were also selected and plotted (approximately without surveys) on the control maps.

5. During the OFT, only four of the five prepared routes were used because of time limitations of the availability of the test squad. The scenario and route used in trial was selected impromptu on the test day just before the trial was performed.

6. On trials 1, 2, 3 and 5, there were one or two lines of five SPAL with 10-meter intervals between each SPAL; on trial 4, there were no SPAL lines. After the final locations were selected by the Exercise Director (ED), the SPAL were immediately wired and emplaced before each trial. Time to accomplish this ranged from 30 to 60 minutes. Some final changes to SPAL line adjustments were made during emplacement to cope with prevailing wind directions. These changes were surveyed from the CP and plotted on control maps prior to the respective trials.

7. The SPAL launch and operator positions were concealed using available vegetation. SPAL position marking stakes, including those at the alternate locations, were removed before each trial began. No special preparations were required at any of the launch positions, all launch tubes were emplaced with the base stakes provided. All launch tubes and bottles were numbered to aid in recovery identification. Appendix J lists the Inventory Control Numbers (ICN) of the SPAL hardware used in the OFT. When mine or gas markers were used, they were emplaced at the same time as the SPAL and at least 20 meters from SPAL locations.

Exercise Control

1. Two independent radio nets were used to control the exercise:

a. Control Net: Exercise Director (ED) at the Control Point (CP), Umpire (UM) accompanying the test squad in a control vehicle, aggressor forces leader, and SPAL operators.

b. Tactical Net: Tactical Controller (TC) accompanying the test squad in a control vehicle and Squad Leader (SL) through Squad Radio Telephone Operator (RTO).

2. Conduct of each trial, except trial 4 when no SPAL were used, was controlled by the ED at the CP. The ED used a theodolite and a control map to continuously monitor the position of the squad. Wind direction was continuously monitored and updated periodically on the SPAL location map. The ED ordered SPAL, artillery simulator, and aggressor forces attacks after the UM confirmed that no squad members were within danger zones, i.e., within 25 meters of SPAL launch positions. SPAL attacks were delivered when the squad reached a CP bearing which intersected the downwind vector plotted from the center of the SPAL launch positions.

3. The tactical mission the squad was to perform was contained in written Operations Orders (OO) which were given them at the start of each trial. The OO (Appendix D), which were prepared by OCCS, included an area map showing the starting point, objective, terrain features, known hazardous areas (mine or gas), but not the SPAL positions.

4. Each member of the test squad was assigned an identification number prior to the start of the trials.

5. Once the trial had started, the exercise could be stopped for two reasons:

a. For safety or communications reasons (Tactical Halt) or,

b. for evaluation and data recording reasons (Administrative Halt).

Performance Assessment

1. After each SPAL attack the trial was administratively halted to permit evaluation of the attack by controller personnel as follows:

- a. Controller personnel observed and recorded unit masking time.
 - b. Positions of the squad members were marked with stakes. The attack plot, showing member positions following each trial and the XM9 papers which were marked, is given in Appendix G.
 - c. Controller personnel checked and recorded whether or not XM9 Detector papers were marked. If the detector paper was marked, it was removed and replaced (after personal decontamination) with new detector paper.
 - d. The plots were analyzed to determine SPAL area coverage and to aid in quantifying the number of casualties that would have occurred in an actual attack.
2. Evaluations of chemical defense procedures, military effectiveness and doctrinal conclusions are based on the following:
- a. Umpires' observations (Appendix H).
 - b. Tactical Controllers' Notes and observations, Exercise Directors' notes, and data from other military observers. These notes and data were used to prepare the synopses (Appendix E) for each trial. The TC's were qualified CmlC officers attached to OCCS.
 - c. CSL (Biomedical Laboratory's [BML]) expert on skin decontamination observed the personal decontamination procedures throughout the OFT. His observations are given in Appendix I.
3. Motion pictures were taken intermittantly throughout the trials, from the CP and from the control vehicles. The SPAL hardware was recovered after each trial. The motion pictures and recovered hardware were used to prepare the OFT RAM (Appendix J).

FINDINGS

1. The SPAL system adequately simulates an on, or near, target artillery airburst persistent chemical agent attack, but not a covert "toxic rain" attack.
 - a. SPAL bottles produced visible and audible signatures upon airburst. To what extent the SPAL signature is similar to actual chemical airburst rounds is uncertain. The SPAL signature is different from the M74 Artillery Airburst Simulator which bursts higher, produces a louder report, and more smoke.
 - b. Upon airburst, each SPAL bottle produces droplets of simulant which produce a downwind pattern of ground contamination at least 10 meters wide by 50 meters long, detectable by M8 and XM9 Detector Paper. In this regard, the simulant agent CAST 1, behaves as would an unthickened persistent agent. However, the droplet particle size distribution produced by SPAL is somewhat larger than that which would be produced by an airburst chemical shell; i.e., 900 to 1,000 micron mass median diameter for SPAL versus 200 to 500 micron mass median diameter for a chemical shell.

c. Since CAST 1 activates detector papers, it allows individuals to recognize that they have been subjected to a chemical attack. For the same reason, it allows umpires and other controller personnel to assess the effectiveness of an attack in terms of the number of droplet marks which appear on detector papers worn by individuals.

2. Proper use of the SPAL system enables a trainer to conduct integrated chemical defense training realistically.

a. In a tactical scenario the trainee will sense that the surroundings have become contaminated when SPAL is used. To an extent, it is not necessary to interrupt the tactical scenario to assess the effectiveness of training. The method and sequence of actions the trainee takes in response to the attack—and, where appropriate, the length of time to take these actions—can be observed and used as a qualitative measure of training proficiency.

b. Other than producing reactions with the detector paper, CAST 1, the present simulant agent does not produce effects which allow for quantitative assessment of proficiency in the use of protection equipment such as the mask and hood, decontamination equipment such as the M58 Training Aid and M13 Kit (without B1 dye) and the M256 Detector Kit. There also is no physiological penalty for improper use of the protection and decontamination equipment, and there is no reaction with the detector kit components.

3. The SPAL system is safe and reliable to use; however, careful planning and control is necessary for safe and effective use.

a. In the US assessment of SPAL, to date, there have been no injuries to personnel. The principal safety issues; i.e., SPAL fragments and EMR initiation, have been addressed and necessary safeguards are incorporated in the US Operator's Manual for SPAL. CAST 1 has been approved by OTSG for training use and TECOM issued a favorable Safety Release for SPAL.

b. The SPAL system meets the reliability requirements given in the TDLR. Further, the US assessment has prompted the UK to make a minor design change to the SPAL hardware vehicle should further enhance reliability; viz., split the foam obdurator in half to reduce the likelihood that the obdurator and firing leads will restrain bottle flight. CSL has conducted tests which confirm that this change is beneficial. Further problems with SPAL parts fit which tend to impede assembly have been brought to the attention of the SPAL hardware manufacturer. The manufacturer has prepared a detailed quality control plan which will be used in the manufacture of US parts and which should eliminate the parts fit problem.

c. For unit training, SPAL should be used in multiples to obtain satisfactory breadth of area coverage. Simultaneous use of five SPAL is satisfactory for a squad size unit operating in a tactical scenario. A direct SPAL attack is most effective; i.e., most unit members reached with contamination, when the wind direction is steady and the unit receiving the attack is directly downwind from the launch line.

d. For a realistic precontamination encounter, it is not necessary to resort to the expense of using SPAL. CAST 1 can be disseminated to contaminate ground, cover, and equipment by numerous spray devices.

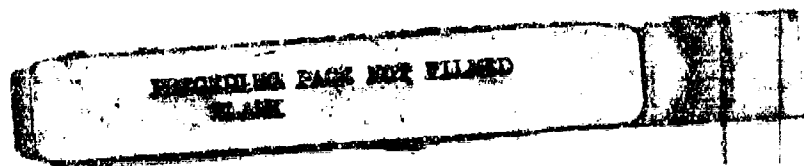
CONCLUSIONS

The Operational Feasibility Test has demonstrated that:

1. The XM9 SPAL meets the requirements for Phase I of the Training System for Chemical Defense as identified in the Training Device Letter Requirement (TDLR).
2. The XM9 SPAL is operationally effective; although not an optimum system, it fulfills the need for an interim system for chemical defense training by the US Army.

APPENDIX A

OFT ISSUES



OFT ISSUES

<u>ITEM</u>	<u>SOURCE</u>	<u>ISSUE</u>	<u>CRITERION</u>
1	TDLR Para 2a	Mission Performance	Does the system provide realistic chemical operations training? a. Create a simulated chemical warfare environment in which unit personnel can practice chemical defense procedures with primary emphasis on decontamination of personnel and equipment and proper masking procedure. b. Provide the capability to simulate air delivery of persistent chemical agents. c. Provide a method to realistically assess simulated chemical casualties that would have been incurred in an actual chemical attack.
2	TDLR Para 3	Mission Performance	Does the system permit evaluation of chemical defense procedures? a. Create a simulated chemical warfare environment in which to evaluate the unit's ability to accomplish masking procedures collectively. b. Create a simulated chemical warfare environment in which to evaluate decontamination procedures. c. Allow assessment of various chemical defensive procedures.

<u>ITEM</u>	<u>SOURCE</u>	<u>ISSUE</u>	<u>CRITERIA</u>
3	TDLR Para 5	Training	Is the system safe to use and assess during unit training exercises? a. Be safe to use by control personnel. b. Present negligible hazards to personnel undergoing chemical defense training.
4	TDLR Para 4, Sa(3)	RAM-D	Is the system capable of operating under unit training conditions? Establish the reliability of the airburst simulators.

APPENDIX B

SUMMARY OF PRE-OFT NBC PROFICIENCY TEST RESULTS

Problem: On the chemical battlefield, the individual soldier must mask quickly or he may die from inhaling lethal chemical agents. On the command "Gas", I want you to mask as quickly as you can. However, you must use all proper steps in masking. Do you have any questions?
"Gas!"

<u>Subject No.</u>	<u>Masking Time</u>	<u>Clear Properly</u>	<u>Comment</u>
1	Incomplete	No	
2	15 sec	Yes	
3	15 sec	Yes	
4	13 sec	Yes	
5	13 sec	No	
6	17 sec	No	Mask not prepared
7	14 sec	No	Never used hand before
8	18 sec	Yes	
9	10 sec	Yes	
10	18 sec	No	Clearing steps out of order

Total Pass: 5

1 Marginal

Problem: As you were moving through some underbrush on a combat patrol, you noticed a sticky substance on your hand. You believe that this substance is a chemical agent. Using any equipment you are carrying plus the articles you see before you, take any appropriate measures you feel are necessary.

<u>Subject No.</u>	<u>Did they mask?</u>	<u>Use M58 properly?</u>	<u>Use M13?</u>	<u>Use Atropine?</u>
1	Yes (no clear)	Yes	No	No
2	No	Yes	No	No
3	No	No	Yes	No
4	Yes	Partial- (used sticks last. Did not know directions)	No	No
5	No	Yes-(read directions)	No	No
6	No	No	No	No
7	No	Yes	No	No
8	No	No	Yes	No
9	No	Yes	No	No
10	No	No	Yes	No

APPENDIX C
OFT PROTOCOL

Protocol for Military Potential Test (Operational Phase) of
the Modified UK Simulator, Projectile, Airburst, Liquid
(SPAL) Training System

1. Principal Investigator: Samuel E. Jackson, Jr.
2. Project Title: Military Potential Test (Operational Phase) of the Modified UK Simulator, Projectile, Airburst, Liquid (SPAL) Training System.
3. Objective: To validate the utility of SPAL as a training system when employed in conjunction with proposed US training doctrine.¹
4. Background:

a. This project is concerned with the training of individuals and units to correctly use chemical defensive materiel in order to survive and accomplish their mission on a chemical battlefield. The requirement for effective simulant chemical agents and simulant agent disseminator systems to aid in chemical defensive training was first identified in WW I. Until 1972 the most effective chemical training was conducted using a diluted form of the live agent distilled mustard (HD). In 1972, the authority to use this agent was rescinded creating a training void and an urgent requirement for realistic simulant agents. Moreover, with the diminishing manpower available in the Army, the requirement for an efficient simulant agent dissemination system became imperative. The UK SPAL, modified for US use by filling the training device with a simulant consisting of 10 wt % solution of water in polyethylene glycol-200 (PEG-200), has been proposed as an interim item to provide a quick-fix to meet this current training void recognized by USA Training and Doctrine Command (TRADOC).

b. There are currently no standard agent-disseminator combination which are designed to simulate an airburst (toxic rain) attack. To date, no operational-type tests of the UK SPAL, modified by filling with PEG-200, have been conducted. At the Meeting of the Joint Working Group on Chemical Agent Training Systems (CATES) held on 16 June 1976, it was decided that operational-type testing of the UK SPAL would actually be a Military Potential Test (Operational Phase) and that this test would be conducted by the Edgewood Detachment of the US Army Human Engineering Laboratory (USAHEL).²

¹AR 310-25, defines utility as "The military/operational value of an item/system when measured from within a pertinent Army Concept Program and against the threat analysis and future concept, doctrine, environment, organization, skills, availability, reliability, maintainability, obsolescence and other materiel objectives/requirements."

²Letter, SAREA-PL, EWA, 18 June 1976, subject: Meeting of Joint Working Group on Chemical Agent Training Equipment System (CATES) with 1 Incl.

5. Plan:

A. Scope. The Military Potential Test (MPT) of the SPAL is designed to determine that the SPAL training system meet the following criteria:

- (1) The munition:
 - a. Is safe to use in conjunction with troops.
 - b. Requires only one individual to function the simulator.
 - c. Distributes simulant agent droplets of sufficient size and density to be detected by M8 Detector Paper and XM9 Detector paper over an area sufficient to support squad level chemical defense training.
 - d. Can be transported by one person.
- (2) The agent:
 - a. Will react with the M8 Paper and XM9 Detector Paper.
 - b. Will not flash when used in/with exploding munitions.
- (3) The training system, by realistically simulating a direct chemical agent attack by airburst weapons, is an effective agent-dissemination system with which to train troops to perform automatic masking and individual decontamination procedures.

These criteria were established by the Training Device Letter Requirement (TDLR) for the Modified UK Simulator, Projectile, Airburst, Liquid (SPAL) Training System (TRADOC ACN 21803) (Appendix A). The MPT will be a controlled field exercise based on a training scenario provided by US Army Ordnance and Chemical Center and School (also found in Appendix A) and USATECOM.³ The test unit will be an infantry squad (non-motorized) composed of direct combat or combat support troops. The test training units and exercise are described in paragraphs 5C and 5F. The MPT will be conducted at Edgewood Area of Aberdeen Proving Ground, MD. All activities described in this protocol are within the bounds of normal duty/training for Infantry MOS qualified soldiers.

The data, both quantitative and qualitative, will be collected by trained observers and umpires. These data will be used to determine whether the UK SPAL satisfies the requirements stated in the TDLR.

³USA Test and Evaluation Command. Test Operations Procedure (TOP) 8-3-110, Appendix B, Controlled Field Exercise-Tactical Use of Field Protective Masks. 16 November 1972,

B. Description of Test Item. Chapters 1 and 2 of the User Handbook for the UK SPAL give the description and methods of operation of the unmodified SPAL.⁴ These chapters are shown as Appendix B. The SPAL is modified for US use, as explained in paragraph 4 above, by filling the training device with a simulant consisting of 10 wt % solution of water in polyethylene glycol-200 (PEG-200) instead of Chemical Agent Training Mixture-2 (CATM-2), the UK training simulant. Appendix C contains a description of PEG-200 with supporting biomedical technical data.

C. Subjects.

(1) Test Squad. The test squad to receive the training will be drawn from a direct combat support or direct combat unit to be designated by FORSCOM.

(2) Aggressor Forces. The aggressor harrassment will be provided by military personnel from Headquarters & Headquarters Company, Chemical Systems Laboratory, ARRAIDCOM, Aberdeen Proving Ground, MD.

All military personnel will be males between the ages of 18 and 25 years of age and will be carefully screened. They will be required to have at least a Profile Serial with a "1" as the lowest numerical designator in each of the six PULHES factors (Code A).⁵ This profile must have been verified by a physical examination within the past twelve months. Total number of personnel in the test squad for this MPT will not exceed twenty.

D. Uniform/Equipment Configuration. The test squad will wear the temperate zone uniform, the CB overgarment, CB protective gloves, Standard A body torso armor, and the M1 Helmet. They will carry the M17A1 protective mask with hood, M58 Decontamination Training Aid, and the M13 Decontaminating and Reimpregnating Kit. They will also wear bands of XM9 Detector Paper on those parts of the body specified by the currently proposed use doctrine (Arm at biceps, wrist, and just above the boot). These detector bands will be replaced after each SPAL attack. The XM9 Detector Paper will be handled in strict accordance with a medically approved SOP for the use of the XM9 Detector Paper for this test (Appendix D). The assault load is described in Appendix E. Aggressor uniforms will be determined by Headquarters & Headquarters Company, Chemical Systems Laboratory, however, they will carry and wear the M17A1 mask.

E. Training. The test squad will be MOS qualified, who have attained individual chemical defense standards of proficiency. That is, they will have the knowledge and ability to take the proper defensive actions to survive a chemical attack and the subsequent contamination hazard.

⁴Quality Assurance Directorate (Weapons) Woolwich, Provisional Handbook for the Simulator, Projectile, Airburst, Liquid, L1A1, (SPAL), 1975.

⁵AR 40-501, Standards of Medical Fitness, Feb 72, paragraph 9-5, C28.

Training for this exercise will therefore be limited to a 1 hour review of individual CB defensive techniques (automatic masking and decontamination procedures). Training will be conducted in a nontactical environment by a qualified officer or noncommissioned officer with appropriate training aids.

At the training session the test squad will be carefully briefed concerning the nature of the MPT. The tasks, methods of measurement, and hardships and discomforts to be expected will be explained in detail.

F. Test Procedures.

(1) Tactical Concept. A sketch of the tactical concept (TC) is presented in the Figure. The test unit will (a) foot march over improved and unimproved roads and cross-country; (b) attack, consolidate and defend an objective area; (c) undergo SPAL attacks at those approximate locations indicated in the figure; (d) after each SPAL attack take individual CB protective actions (automatic masking and personal decontamination). The soldiers will be instructed to begin masking procedures as soon as they notice a specified change in the XM9 detector bands they are wearing (the bands will become stippled with red spots). The detector bands will be located on those easily observable parts of the body described in paragraph 5D above. After each SPAL attack, all tactical movement ceases so that SPAL/subjects performance for that particular segment of the TC can be assessed. After the assessment has been made, the action will resume until the next SPAL attack occurs and the assessment procedure is repeated. This schedule will be followed until the TC is completed. The exercise will consist of six iterations of the TC conducted over three test days (one each morning; one each afternoon). Aggressor harassment will occur ad lib throughout the exercise.

(2) Control. Control will be exercised by an umpire who will be a qualified officer or noncommissioned officer who is personally responsible for controlling exercise movement.

(3) Performance Assessment.

a. Each soldier in the test unit will wear on his helmet a band of XM9 Detector Paper. Test observers will be equipped with grid sheets on which they will indicate those subjects by position and distance from the SPAL who have been exposed to the simulated toxic rain as determined by the XM9 Detector Paper on the soldiers' helmets.

b. Each soldier in the test unit, after each SPAL attack must:

1. Be able to recognize the visual chemical alarm (change in XM9 detector band).
2. Properly put on, seat, clear, and check his protective mask within 9 seconds following the attack.

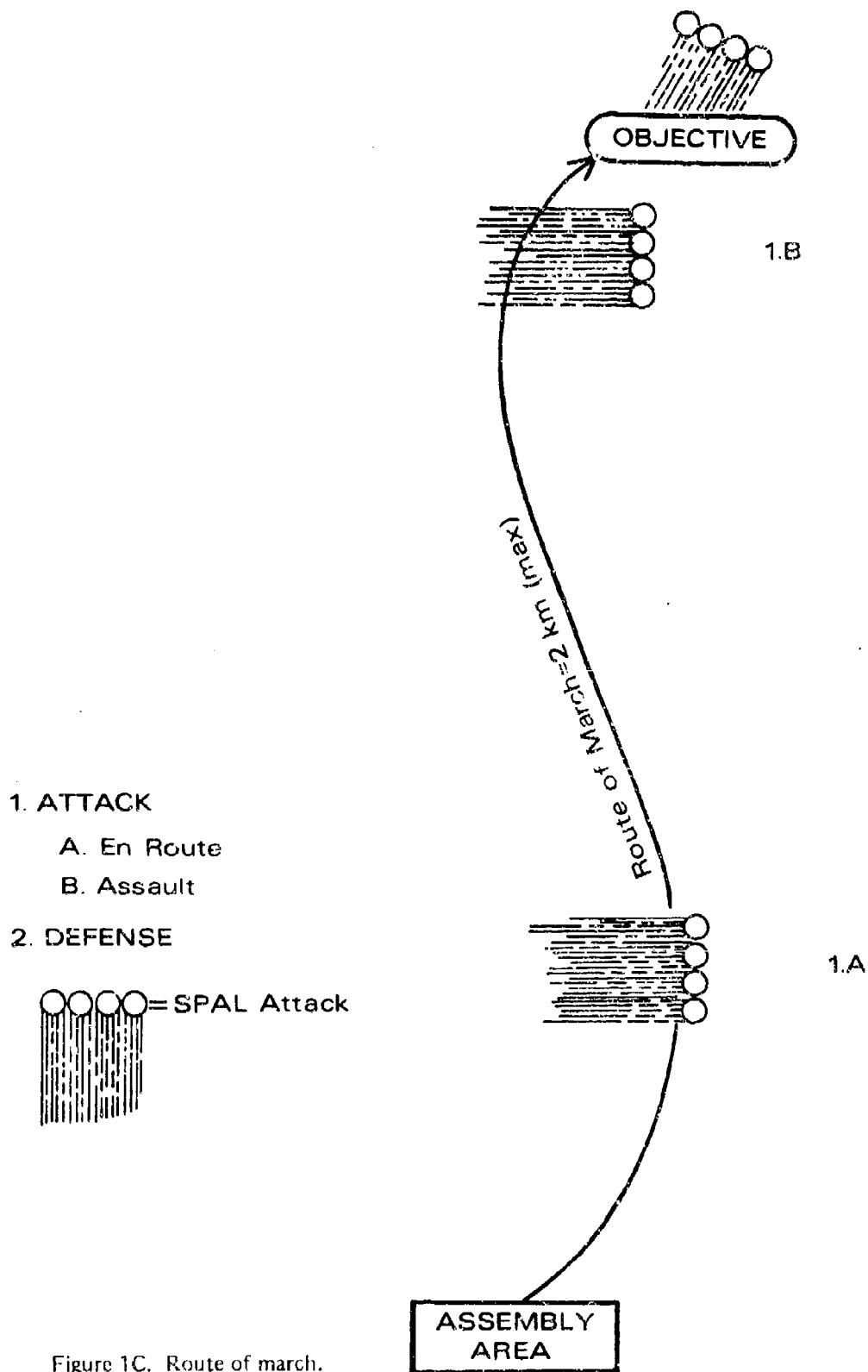


Figure 1C. Route of march.

3. Perform simple decontamination of his person, clothing, personal equipment and individual weapon after masking using the M58 Skin Decontaminating Training Aid and the M17 Individual Decontamination and Reimpregnating Kit.

c. Analytical Plan.

1. The plots on the grid sheets will be analyzed to determine the squad area covered by each SPAL attack. These plots will aid in quantifying the number of chemical casualties that would have incurred in an actual chemical attack.

2. The umpire test evaluation personnel will time the unit's ability to accomplish masking procedures collectively. Timing will begin when the alarm is given and will cease 9 seconds later. Those test subjects not properly masked within that time will be considered casualties and from this a unit casualty percentage will be determined.

3. The umpire and test observers will check with M8 paper to assure that decontamination procedures have been followed.

d. Rationale:

Two of the primary goals that are desired of chemical defense training are individual/unit proficiency in decontamination procedures and proper maskings. Current chemical defense training does not allow for adequate evaluation of proficiency of these tasks in a realistic training situation. A quantitative method of assessment of chemical casualties will provide a more realistic training situation.

G. Risks.

(1) Exercise. The risks associated with this exercise are no more than the everyday risks encountered by Infantry soldiers performing MOS-related training and duties. These risks, being no greater than usual, include fatigue, noise, muscle strain, cuts, abrasions, and skin irritations.

(2) Simulant. PEG-200 is approved by the Surgeon General for world wide use.

(3) SPAL. The SPAL is considered safe to use when satisfactory safeguards are taken. Those safeguards are detailed in paragraph 5H.

(4) XM9 Detector Paper. The B-1 dye in the XM9 Detector Paper is MUTAGENIC as determined by the Biomedical Laboratory. At a special IPR held on 25 May 1977, it was decided that the paper could be used in tests if medically approved precautions were observed. Such precautions are outlined in Appendix E of this protocol.

H. Safety Precautions.

(1) SPAL

a. A safety distance of not less than 15 meters from the SPAL positions will be observed. This safety zone will be delineated along the route of march by white engineer's tape.

b. All personnel engaged in the exercise will wear steel helmets.

c. SPALs will not be sited on broken/sloping ground due to possible adverse effect on burst height and danger area.

d. Particular care will be taken to insure that the SPALs are fixed firmly ("planted") in the upright position.

e. Once "planted", every effort will be made to insure that the SPALs cannot be tilted inadvertently from their upright positions or overturned.

f. Wearing the EAR type earplugs will be mandatory during the exercise.

g. In addition to the control functions cited in paragraph 5F(2), the umpire has the authority to administratively halt the ploy of the exercise to insure troop safety.

h. The umpire will have direct communication with the Test Officer who in turn will have access to both on-the-scene and remote medical personnel.

The SPAL safety precautions were established by the UK Ordnance Board⁶ for the unmodified SPAL to provide satisfactory safeguards against hazards used by "blinds" (when the simulator fires and projects a bottle, which fails to burst in the air) or projection at low angles of elevation. Data from tests conducted by Directorate of Development and Engineering at the Edgewood Area, APG, MD, in July 1976, indicate that the SPAL, modified by filling with PEG-200, does not significantly differ in performance, i.e., impact distance from launch, from the unmodified UK SPAL. These data are attached to Appendix B.

(2) XM9 Detector Paper. XM9 safety precautions are listed in Appendix D.

I. Medical Support.

(1) A test physician will be assigned by the Director, Biomedical Laboratory, Edgewood Area, APG, MD.

⁶

Ordnance Board Proceeding No. 41364, "Actuating Charge for Simulator, Projectile, Air-Burst (Liquid Chemical Agent), X11E1, 14 Aug 73 (UK RESTRICTED).

(2) If the Edgewood Area Medical Review Board deems field medical support necessary, US Army Kirk Army Hospital has agreed to provide, upon request, such support. The extent of the field medical support will be determined by the Commander, US Army Kirk Army Hospital.

6. References.

- a. Army Regulation 310-25. Dictionary of US Army Terms.
- b. Letter, SARFA-PL, EWA, 18 June 1976, subject: Meeting of Joint Working Group on Chemical Agent Training Equipment System (CATES) with 1 Incl.
- c. USA Test and Evaluation Command Test Operation Procedure (TOP) 8-3-110, Appendix B, Controlled Field Exercise-Tactical Use of Field Protective Mask. 16 November 1972.
- d. Army Regulation 40-501, C28. Standards of Medical Fitness. Feb. 1972.
- e. Ordnance Board Proceeding No. 41364, Actuating Charge for Simulator, Projectile, Air-Burst (Liquid Chemical Agent) XLIEI. 14 August 1973.
- f. Quality Assurance Directorate (Weapons) Woolwich, Provisional User Handbook for the Simulator, Projectile, Airburst, Liquid, LIAI (SPAL). 1975.
- g. Letter, SARFA-DE-MMP, EWA, 14 October 1976, subject: Transmittal of July 1976 Test Data - SPAL with 2 Inclosures.
7. Facilities to be Used: The Military Potential Test (Operational Phase) will be conducted at "G" and "N" fields of Gun Powder Test Area, AFG, MD 21014.
8. Time Required to Complete: The testing, as described in paragraph 5 of this proposed protocol, will require one week to complete.
9. Personnel to Conduct Project: (A short biographical sketch for the Principal Investigator will be found under TAB.)

Principal Investigator - Samuel E. Jackson, Jr.
Senior Test Technician - Ronald P. Merkey
Test Medical Officer - To be assigned by Biomedical Laboratory
Division, Chemical Systems Laboratory.
Exercise Umpire - To be assigned by US Army Ordnance and
Chemical Center and School.

10. Funding Implications: N/A

11. Date Prepared: 8 November 1976. Rev 15 February 77, 20 April 77,
17 June 77, 26 August 77.

APPENDIX D

TRIAL OPERATIONS ORDERS

BY

William Terry, CPT, CmlC
David Lindsay, 1LT, CmlC

OPERATIONS ORDER

FOR TRIAL 1

(Operations Order issued at 0930; 13 September 1977)

1. SITUATION

a. Enemy. Our intelligence states that enemy forces are retreating from this area to the south but they have left behind small units to delay our advance. They have also laid minefields to delay our advance. The enemy units are believed to be equipped with small automatic weapons but may have artillery support. The weather is clear, temperature is approximately 70°F, wind direction predominantly from SW at 8 mph with gusts to 20 mph. The terrain in this area is basically flat to lightly rolling. Most of the area is covered by high brush and trees.

b. Friendly. Company B is performing mop-up operations to the East. Second, third and fourth squads of our platoon are operating to the West with the remainder of our company. Direct support artillery is being provided for our company by A Battery, 1/5 Artillery which is on call to the company.

2. MISSION

Your squad will attack and secure the BUNKER in the vicinity of E001800 N555100 and hold it until relieved.

3. EXECUTION

a. General. The BUNKER is believed to be occupied by an enemy FA observation element.

Your squad will depart the assembly area at approximately 1050.

Minefields are known to be located and marked as shown on your map. However other minefields may be in the area. The fields are being marked as they are located. There is also a field of persistent agent contamination on the west side of Ricketts Point Road in the vicinity of the objective that is to be avoided.

b. Route. Follow the woodline parallel to Ricketts Point Road until your squad reaches the minefield (which is marked on your map). Move out of the trees only long enough to pass the minefield, then move back into the treeline until even with the objective. Move into your attack position.

A preplanned artillery attack is laid on for you once your squad is in the attack position. Your fire mission is coded Objective 1.

4. SERVICE AND SUPPORT

Your squad will carry one canteen of water--no rations.

Uniform and equipment will be by SOP.

5. COMMAND AND SIGNAL

Your primary frequency will be 36.10. Your alternate frequency will be 47.80. Your call signal is YDH24. The company call signal is YDH55.

OPERATIONS ORDER

FOR

TRIAL 2

(Operations Order issued at 1530; 13 September 1977)

1. SITUATION

a. Enemy. Our intelligence states that enemy forces are beginning to move into this area from the south. It is thought at present that small recon patrols are already operating in the area. These patrols are believed to be equipped with only small automatic weapons but may have artillery support. The weather is clear, temperature is approximately 70°F, wind direction predominantly from SW at 8 mph with gusts to 22 mph. The terrain in this area is basically flat to lightly rolling. Most of the area is covered by high brush and trees. They are also swampy areas.

b. Friendly. Company B is moving up to occupy positions to the West. Second, third and fourth squads of our platoon are operating to the East with the remainder of our company. Direct support artillery is being provided by B Battery, 1/5 Artillery which is on call to the company.

2. MISSION

Your squad will move to and occupy the buildings and road junction in the vicinity of E998400 N556200 and hold it until relieved.

3. EXECUTION

a. General. The buildings and road junction are not expected to be occupied yet by enemy forces. However, be prepared to receive an attack from the South coming up Watson Creek Road.

Your squad will depart the assembly area at approximately 1615.

Minefields are known to be located and marked as shown on your map. However, other minefields may be in the area. There is also believed to be a field of persistent agent contamination to the south of the objective along Watson Creek Road.

b. Route. From the AA move to the south just inside the wood line until your squad reaches the swamp. Come out on Maxwell Point Road only long enough to pass the swamp. Then move back into the wood line and move to the West parallel to Maxwell Point Road until your squad reaches the objective.

4. SERVICE AND SUPPORT

Your squad will carry one canteen of water--no rations.

Uniform and equipment will be by SOP.

5. COMMAND AND SIGNAL

Your primary frequency will be 36.10. Your alternate frequency will be 47.80. Your call signal is YDH24. The company call signal is YDH55.

OPERATIONS ORDER
FOR
TRIAL 3

(Operations Order issued at 0900; 14 September 1977)

1. SITUATION

a. Enemy. Our intelligence believes that enemy forces intend to occupy this area within the next 24 hours from the East. Enemy recon patrols have been spotted in the area. These patrols are believed to be equipped with only small automatic weapons but may have artillery support. The weather is partly cloudy, temperature is approximately 72°F, wind direction predominately from the SW at 8 mph with gusts to 20 mph. The terrain in this area is basically flat with some of the area covered by high brush and tree stands. There is also a large swampy area to the west of Watson Creek Road.

b. Friendly. All of our forces are just to the North and West of us preparing to defend this area against the expected upcoming attack except other recon patrols are operating to the South and East. However, none of these patrols should interfere with this operation. Direct support artillery is being provided by B Battery, 1/5 Artillery which is on call to the company. Use the observation Towers as a reference point to call for fire if it is needed.

2. MISSION

Your squad will move North and secure the twin Observation Towers in the vicinity of E997500 N 555500 as an OP and hold it until relieved. Report any enemy movement immediately to the company.

3. EXECUTION

a. General. The Observation Towers are believed to be undefended.

Your squad will depart the assembly area at approximately 0930.

Minefields are known to be located and marked as shown on your map. There is also a field of G-type persistent agent contamination in the swampy area to the west of Watson Creek Road that is to be avoided.

b. Route. Follow the tree line just to the West and parallel to Watson Creek Road until your squad reaches the clearing. Then turn NW and follow the gravel road to the Observation Towers using any available concealment.

4. SERVICE AND SUPPORT

Your squad will carry one canteen of water--no rations.

Uniform and equipment will be by SOP.

5. COMMAND AND SIGNAL

Your primary frequency will be 36.10. Your alternate frequency will be 47.80. Your call signal is YDH24. The company call signal is YDH55.

OPERATIONS ORDER

FOR

TRIAL 4

(Operations Order issued at 1330; 14 September 1977)

1. SITUATION

a. Enemy. Our intelligence states that no heavy enemy troop activity has been reported in the area during the last 24 hours. However, enemy artillery H & I fire and sniper fire have been frequent. The weather is partly cloudy, temperature is approximately 76°F, wind direction predominately from the NW at 8 mph with gusts to 17 mph. The terrain in this area is basically flat and swampy with the remainder of the ground covered by heavy underbrush and trees.

b. Company A, 1st BAT is occupying a blocking position in the vicinity of E995000 N555500 along Maxwell Point Road. Elements of Company B, 1st BAT are preparing blocking positions along Hoadley Road north of Maxwell Point Road. Both companies received chemical attacks last night.

2. MISSION

Your squad will move West and reinforce Company A.

3. EXECUTION

a. General. Maxwell Point Road was clear as of 0600 this morning but enemy snipers may now be in the area. Your squad will depart the assembly area at the RJ of Maxwell Point Road and Watson Creek Road at approximately 1400.

b. Route. Make a tactical road march west along Maxwell Point Road until contact is made with Company A. Report to the Company Commander upon arrival.

4. SERVICE AND SUPPORT

Your squad will carry one canteen of water--no rations.

Uniform and equipment will be by SOP.

5. COMMAND AND SIGNAL

Your primary frequency will be 36.10. Your alternate frequency will be 47.80. Your call signal is YDH24. The company call signal is YDH55.

OPERATIONS ORDER

FOR

TRIAL 5

(Operations Order Issued at 1010; 15 September 1977)

1. SITUATION

a. Enemy. Our intelligence states that enemy forces have retreated from this area during the last several days and no activity should currently be in the area. The enemy has laid minefields on and along roads to delay our advance. Ricketts Point Road to the North of the RJ with the gravel road shown on your map is known to be mined. The weather is clear, temperature is approximately 66°F, wind direction variable from N at 3 mph with gusts to 10 mph. The terrain in this area is basically flat to lightly rolling. Most of the area is covered by high brush with some tree stands.

b. Friendly. Bravo Company of 1st BAT will be on the left and 2nd, 3rd, and 4th squads of 1st Platoon of our Company (Alpha Company), 1st BAT will be on the right. All units of 1st BAT are moving up to the North to secure our right flank. The 2nd and 3rd Battalions are continuing the attack to the West. The only available Artillery support is GS which is being coordinated by 2nd Platoon.

2. MISSION

Your squad will move up, secure, and hold the prepared position on our right flank in the vicinity of E001700 N562200. Do not advance beyond the vicinity of the prepared positions. Report in by radio when you have secured the position.

3. EXECUTION

a. General. Your squad will depart the Assembly Area at 1040. Avoid mine fields! Also avoid the field of persistent agent contamination to the NW of Ricketts Point Road as shown on your map. The mine fields and contamination fields are marked.

b. Route. From the AA move North along Ricketts Point Road to the RJ with the gravel road. Parallel Ricketts Point Road on the west side avoiding the road which is mined until you reach the prepared positions.

c. Extra Instructions. In the event of enemy contact prior to reaching the objective, fall back to the staging area.

4. SERVICE AND SUPPORT

Your squad will carry one canteen of water--no rations.

Uniform and equipment will be by SOP.

5. COMMAND AND SIGNAL

Your primary frequency will be 36.10. Your alternate frequency will be 47.80. Your call signal is YDH24. The company call signal is YDH55. The call signal for Artillery Support from 2nd Platoon is YDH35. The 2nd Platoon frequency is 39.40.

APPENDIX E

TRIAL SYNOPSIS

BY

David Lindsay, 1LT, CmlC
John Dickie III
Lew D'Elisio
Samuel E. Jackson, Jr.

SYNOPSIS OF TRIAL 1

(Refer to Figure 1F, page 59)

1. In this trial the scenario was a tactical movement to occupy a defended objective as shown in Figure 1F. Two direct SPAL attacks were delivered in this trial, one while enroute and one during the assault on the objective. Artillery simulators were used to:

a. Condition the squad to respond properly to any kind of artillery attack, viz., to mask.

b. Require the squad to use their LAD papers to discriminate between conventional and chemical attacks.

c. Accelerate squad movement.

Gas and mine markers, rather than natural terrain features, were used to channel the squad to and through the SPAL attack sites.

2. The purposes of conducting the trial in this manner were to:

a. Determine if SPAL could be used to deliver a simulated chemical airburst attack against a moving squad operating in a tactical scenario.

b. Assess squad response to direct chemical airburst, and conventional artillery air and ground burst attacks.

c. Assess squad personal decontamination procedures.

d. Assess the use of safety goggles as a means of providing added protection from SPAL fragments.

3. The test soldiers, i.e., the squad, moved into the Assembly Area (AA, point 1) at 0915.

a. The Squad Leader (SL) was given the Operations Order, Appendix D, at 0930 by the Tactical Controller (CPT, CmlC). The SL was also given a PRC 77 radio, a compass, binoculars, an area map, and an M256 Detection Kit. Squad members were given individual decontamination equipment, i.e., two each prototype M58 Skin Decon Training Aids and two each M13 Equipment Decon Kits, and industrial type safety goggles.

b. LAD paper was affixed to each squad member by Human Engineering Laboratory (HEL) personnel. LAD papers were affixed to the helmet, arm (bicep), wrist and ankle of each soldier and each strip of paper was marked to denote the trial number, the SPAL attack number, the soldier's assigned serial number and the body location of the strip.

c. The SL gave the Operations Order to the squad. The squad was given 20 minutes to check its equipment and to prepare for the mission. Each member was wearing the chemical protective overgarment and industrial goggles, and carried chemical protective gloves and the M17A1 protective mask with hood.

4. The squad moved out of the AA in a squad column, fire teams abreast in Mission-Oriented Protective Posture (MOPP) 3 at 1050 into the tree line toward the objective as shown in Figure 1F. The control vehicles, with the Tactical Controller (TC), Umpire (UM), observers and data collectors, followed about 50 meters behind the squad to the right of the tree line with respect to the line of march.

5. At 1055 when the squad had reached the approximate position denoted as point 3, a prearranged enemy harassing and interdiction (H and I) artillery attack was delivered at point 2 by aggressor forces using M115 Artillery Ground Burst Simulators (AGBS). The squad members removed the goggles and donned protective masks and hoods, i.e., assumed MOPP 2. (The test squad should have inspected their LAD papers and, finding no markings, should have concluded that they had not received a persistent agent chemical attack. Hence, they required no decontamination but should have maintained MOPP 2. Whether or not they checked their LAD paper was not observed; however, they did remain in MOPP 2.) They then sped up their movement to the objective.

6. At 1105 when the squad was at approximately point 4, well within the tree line, the TC (by radio) directed the squad to establish its right flank on the edge of the tree line. There was no tactical basis for ordering the squad to take this action. It was done purely for exercise control purposes, to assure that the squad would encounter the mine field obstacle on their left flank and so be channeled to the preselected SPAL attack site. The squad overreacted and moved too far to the right, emerging well beyond the main tree line which was somewhat poorly defined at this location. The squad moved as far as point 5, circumventing the right flank mine field markers and placing them in the immediate vicinity of the SPAL launch line which had been sited to be within the right flank mine field. This encounter probably removed some of the element of surprise from the subsequent SPAL attack. The mine fields had been defined with markers to channel the squad downwind and a safe distance from the SPAL line. Presumably, the squad failed to recognize the right flank mine field due to inadequate marking in the heavy underbrush and/or due to a restrictive field of view caused by wearing of the protective mask. During this excursion to point 5, members of the squad came into the view of the Exercise Director (ED) from the Control Point (CP) for the first time in the trial. Up to this time the ED had only been able to observe the movement of the control vehicles.

7. At this point in the trial the TC (by radio) ordered the squad to retreat from the mine field, to re-enter the main tree line, to assume MOPP 3 status and to continue the mission. Shortly thereafter, at point 6, the squad encountered the left flank mine field markers, approximately 25 meters within the parallel to the tree line. This obstacle resulted in the squad moving to the right with elements of the squad's right flank remaining within the tree line.

8. In the vicinity of point 7 at 1125, while in MOPP 3 and with goggles on, the squad received a direct SPAL attack. All five SPAL launched and all airburst, however, one SPAL appeared to burst very low. The majority of the squad was within a clearing inside the wood line, in ankle to waist high underbrush, at the time of the attack. After removing goggles, squad members were observed to follow proper masking procedures, including transmitting an audible warning after having masked. Many members were seen to look in the direction where the SPAL had airburst. The squad appeared to react almost immediately to the airburst signatures of the SPAL. The time from the first sign of recognition until the last observed squad member completed donning his mask and hood, and clearing his mask, was about 26 seconds. As masking was completed by individual squad members, their reactions varied. Some remained standing, while others assumed a kneeling or prone posture.

9. At this point, the exercise was administratively halted by prearranged horn signal, and controller personnel moved into the targeted area. (It was observed that the RTO had donned his protective gloves following the SPAL attack prior to decontamination of his hands. This procedure is contrary to doctrine because the inside portion of the protective gloves will become contaminated if the individual's hands are contaminated. Further skin decon of the hands will thus have little effect if the contaminated gloves are redonned.)

a. Simulant agent contamination marks on the LAD papers were readily identified as dark red spots of varying diameter and number density. Furthermore, simulant droplets were observed on vegetation, i.e., leaves and tall grass, throughout the targeted area. Droplets were also observed on personal equipment items, such as mask lenses, hood and overgarment surfaces, weapons, etc. There was no doubt that the targeted area had received a heavy dosage of simulant agent contamination.

b. The position of each member was marked with a stake, the identity of the LAD papers which had been marked with contamination was recorded, and the marked LAD papers were removed and collected. (The attack plot, showing member positions--from a survey following the trial and the LAD papers which were marked, is given in Appendix G.)

c. The squad members were then instructed by the UM to move further along the route, out of the immediate vicinity of the SPAL attack, and to perform decontamination. (Had the exercise not been administratively halted immediately following the SPAL attack, the unit would have been expected to move rapidly out of the immediate vicinity of the artillery attack in MOPP 2, and then perform emergency skin decon and assume MOPP 1

status as quickly as possible. If the mission allowed, the unit should then have moved to a clean area -- using the M256 kit to locate a clean area -- and have performed equipment decontamination.)

10. With the exercise still administratively halted, the squad moved rapidly for approximately 100 meters beyond the attack site, to point 8, approximately 25 meters within the tree line where the members performed individual decontamination. This covered site was selected by the SL and controller personnel were in the immediate vicinity of the squad during decontamination. The following observations were made:

a. Some LAD papers remaining on ankle locations (soldiers 6 and 8) were found to be marked when the squad reached point 8. Presumably, this resulted from simulant transfer and pickup from the surroundings enroute from point 7, since these papers had been previously observed to be unmarked during the inspection at point 7. These papers were not changed.

b. The glass ampule within Capsule II of the prototype M58 Training Aid was difficult to break without breaking the plastic capsule as well. The squad members attempted to break their ampules in various ways, i.e., on helmets or entrenching tools, or with rifle butts. As a result many users lost the contents of the capsule and, so, were unable to conduct proper skin decontamination.

c. With the M58 gauze pad, some users blotted hand contamination, instead of wiping the contamination away from the body. Controller personnel made spot corrections when this was observed.

d. Many squad members failed to put on their protective gloves, i.e., assume MOPP 1, after they had decontaminated their hands and before proceeding with further decontamination. This was noted but not corrected on the spot.

e. Many squad members failed to decontaminate their necks and the inside of their hoods (as instructed during familiarization training) until it was brought to their attention on the spot. This procedure involved use of a buddy system.

f. The M13 Kit was used well, but excessively on the overgarment creating a "snowman" signature on the users. This was noted but not corrected on the spot.

g. Following individual decontamination no evidence of residual contamination on squad member's clothing and equipment was detected with M8 paper as used by controller personnel. New LAD papers, to replace those which had been removed, were applied following this check.

11. The tactical exercise was resumed at 1235 when the SL and Radio Telephone Operator (RTO) used the M256 Chemical Detection Kit, without difficulty and while both were in MOPP 1, and observed a negative response. The SL then ordered the squad to assume MOPP 3 and to resume movement to the objective. Shortly afterward, with the squad at approximately point 9,

a simulated artillery attack was delivered with AGBS in the vicinity of point 10, to accelerate the pace of the exercise. The TC contacted the squad by radio, and informed the squad that enemy artillery fire was being adjusted by observers at the objective and that it was imperative that the objective be taken as soon as possible.

12. Immediately following the artillery attack, the squad assumed MOPP 2 status and moved out rapidly. The main body of the squad halted in the vicinity of point 11, within the tree line, and sent out a recon party to scout the objective. (Note: At this point one member of the squad noticed that he had lost his steel helmet. He was allowed to backtract, to attempt to find his helmet, and he did not participate in the remainder of this trial.) Upon return of the recon party, the squad moved to a concealed (higher underbrush) final assault position, point 12. This movement was observed by the ED at the CP.

13. At 1255, while in the final assault position the SI radioed the TC and called for the preplanned artillery attack on the objective. As prearranged an airburst artillery barrage was delivered above the objective by members of the aggressor forces, then occupying the objective, using M74 AABS.

14. As the barrage ceased, the squad assaulted the objective on line in MOPP 2 status. Aggressor forces fired their weapons at the squad for a short time (with weapons fire returned by the squad) and then retreated south along Ricketts Point Road in jeeps.

15. Shortly after the aggressors had retired, the squad received a direct SPAL attack in the vicinity of point 13 at 1305 about 50 meters from the objective, as the squad was moving to occupy the objective. All five SPAL launched and all airburst. All squad members were standing in waist to chest high underbrush and essentially facing the SPAL line when the attack was delivered. Upon recognizing the attack most squad members assumed a kneeling posture or crouching position until the simulant cloud passed overhead. The squad resumed movement toward the objective but was then administratively halted by the prearranged horn signal approximately 50 seconds following the attack. (Had the exercise not been administratively halted following the resumption of the assault on the objective, the unit should have loosely secured the objective, immediately performed emergency skin decon and assumed MOPP 1 status. As the mission of the squad was to secure and hold the objective until relieved, they must remain in MOPP 1 in a contaminated area. Complete equipment decontamination is not practical; however, items of equipment which must be handled such as weapons and radios should be deconned when time permits.) Controller personnel then moved forward and marked squad members' positions with stakes, read and recorded LAD paper markings and finally, removed and collected all LAD papers. The attack plot is given in Appendix G. As with the first SPAL attack in this trial, the LAD paper marks were readily visible (see paragraph 9a) and droplet contamination was observed on the squad members and the surroundings. The controller vehicle, which was approximately 100 meters downwind from the SPAL line, received heavy droplet contamination. For administrative reasons, the exercise was terminated at this point, i.e., no decontamination was undertaken.

SYNOPSIS OF TRIAL 2

(Refer to Figure 2F, page 60)

1. In this trial the scenario was a tactical movement to occupy an undefended objective. Two direct SPAL attacks were delivered in this trial, one while enroute and one after the objective had been occupied. No artillery simulators were used in this trial. Gas and mine markers, as well as natural terrain features, were used to channel the squad to and through the first SPAL attack site. The purposes of conducting the trial in this manner were to:

- a. Determine if SPAL could be used to deliver a simulated chemical airburst attack against a squad operating in a tactical scenario.
- b. Assess trainee response to direct chemical airburst attacks.
- c. Assess squad personal decontamination procedures.
- d. Assess the use of safety goggles as a means of providing added protection from SPAL fragments.

2. The test soldiers, i.e., the squad, moved into the Assembly Area (AA, point 1) at 1515.

a. The Squad Leader (SL) was given the Operations Order, Appendix D at 1530 by the Tactical Controller (CPT, CmlC). The SL was also given a PRC 77 radio, a compass, binoculars, an area map, and an M256 Detection Kit. Squad members were given individual decontamination equipment, i.e., two each prototype M58 Skin Decon Training Aids and two each M13 Equipment Decon Kits, and industrial type safety goggles.

b. LAD paper was affixed to each squad member by Detection and Alarms Division, CSL personnel. LAD papers were affixed to the helmet, arm (bicep), wrist and ankle of each soldier and each strip of paper was marked to denote the trial number, the SPAL attack number, the soldier's assigned serial number and the body location of the strip.

c. The SL gave the Operations Order to the squad. The squad was given 20 minutes to check its equipment and to prepare for the mission. Each member was wearing the chemical protective overgarment and industrial goggles, and carried chemical protective gloves and the M17A1 protective mask with hood.

3. The squad moved out of the AA in a squad column in Mission-Oriented Protective Posture (MOPP) 3 at 1620 into the tree line toward the objective as shown in Figure 2F. The control vehicles, with the Tactical Controller (TC), Umpire (UM), observers and data collectors, followed about 50 meters behind the squad to the left of the tree line with respect to the line of march.

4. The squad moved to point 2, at the edge of the swamp, where they halted and sent out a two man team to recon the open road area to their front. Upon receiving a clear report from the recon element, the squad advanced along the north side of the road in file. The squad came into view of the ED as they moved onto the road.

5. In the vicinity of point 3 at 1632, while in MOPP 3 and with goggles on, the squad received a direct SPAL attack. Only four SPAL launched and air-burst; one SPAL misfired. Squad members were standing in ankle high underbrush at the time of the attack. Only five members were in a position where they could be observed from the control vehicles during the attack. As they recognized the attack, the observed members of the squad moved into the brush line bordering the swamp on their right flank in an effort to evade the readily visible simulant agent cloud moving towards them. After removing goggles, squad members were observed to follow proper masking procedures, including transmitting an audible alarm. Many squad members again failed to face away from the cloud once the attack was recognized, even though they had been instructed to follow this procedure following the first trial. (The rationale for turning away from an attack is to reduce the change of facial contamination. Currently, the doctrine for facial decontamination is very ill defined.) Again, the squad appeared to react almost immediately to the airburst signature of the SPAL and to kneel or crouch while masking. The time from the first sign of recognition until the last observed squad member completed donning his mask and hood, and clearing his mask, was about 20 seconds.

6. At this point the exercise was administratively halted by the prearranged horn signal. Controller personnel moved into the targeted area, marked squad member positions with stakes, read and recorded LAD paper markings, and removed and collected all marked LAD papers. The attack plot is given in Appendix G. As with previous SPAL attacks in the first trial, the LAD paper marks were readily visible, and droplet contamination was observed on the clothing and equipment of the squad members and on the surroundings. Upon interviewing the squad members, many reported that they had felt droplets impact on their faces and hands as the cloud passed. Those LAD papers which had been marked and removed were replaced.

7. At 1650, with the exercise still administratively halted, the squad was instructed by the UM to move to a position about 100 meters closer to the objective, i.e., to point 4, and to halt, which they did. LAD papers were again inspected. All ten ankle papers and one arm paper were found to be marked with contamination, which was evidence that further contamination had been acquired. Papers which had been marked were removed and the squad was instructed to perform decontamination.

a. Again, problems were observed in the use of Capsule II of the prototype M58 Skin Decon Training Aid as noted in the synopsis of trial 1. However, some improvement in the technique of using the gauze pad to wipe rather than to blot hand contamination was noted.

b. Again, many squad members failed to put on their protective gloves, i.e., assume MOPP 1, after they had decontaminated their hands and before proceeding with further decontamination. The importance of adhering to this procedure had been mentioned in a short critique preceding trial 2, however, on the spot corrections were not made at this point.

c. The ML3 kit was still being used excessively on the overgarment creating the "snowman" signature on the users. This error had also been mentioned in the pre-trial critique, however, on the spot corrections were not made at this point.

d. Following individual decontamination no evidence of residual contamination on squad members, clothing, and equipment was detected with M8 paper as used by controller personnel. New LAD papers, to replace those which had been removed, were applied following this check.

8. The tactical exercise was resumed at 1710 when the SL and RTO, both in MOPP 1, used the M256 Detector Kit without difficulty and observed a negative response. The SL then ordered the squad to assume MOPP 3 and to resume movement to the objective. The squad moved to point 5 where a 2-man team was sent to recon the objective. At 1740, upon return of the recon team, the squad moved in rapidly and occupied the objective.

9. In the vicinity of point 6 at 1745, while in MOPP 3, the squad received a direct SPAL attack. All five SPAL launched and airburst. The entire squad was in file along the south side of the perimeter fence at the objective, standing in ankle high underbrush. All squad members were in view from the control vehicles. All members, after removing goggles, were observed to follow proper masking procedures, including transmitting an audible alarm. Again, virtually all members failed to turn away from the direction of the agent cloud, even though it was highly visible as it moved towards them. In this attack, the squad members began immediate action when they observed the launch signature of the SPAL rather than the airburst. It is reasoned that there were several reasons for this anticipatory behavior:

a. Having been subjected to three previous SPAL attacks, the squad now knew what to expect. SPAL has an audible launch signature and once the bottle rises above ground cover, it moves slow enough to be visually tracked. Further, the SPAL attacks are always delivered from upwind.

b. The SPAL operator was poorly concealed, i.e., within a portable bombproof shelter, in the open about 30 meters to the left of the SPAL launch line in this trial.

The time from the first sign of recognition until the last observed squad member completed donning his mask and hood, and clearing his mask, was about 18 seconds.

10. The exercise was administratively halted by the prearranged horn signal approximately 30 seconds following the attack. Controller personnel then recorded LAD paper markings and finally, removed and collected all LAD papers. The attack plot is given in Appendix G. As with the first SPAL attack in this trial, the LAD paper marks were readily visible and droplet contamination was observed on the squad members and the surroundings. For administrative reasons, the exercise was terminated at this point, i.e., no decontamination was undertaken.

SYNOPSIS OF TRIAL 3

(Refer to Figure 3F, page 61)

1. In this trial the scenario was a tactical movement to occupy an undefended objective as shown in Figure 3F. One direct SPAL attack was delivered in this trial while enroute to the objective. This attack was immediately preceded by an attack with artillery airburst simulators, delivered to draw attention away from the SPAL attack. Gas and mine markers were used to channel the squad to and through the SPAL attack site. The purposes of conducting the trial in this manner were to:

a. Assess trainee response to a direct chemical airburst attack, coordinated with a conventional artillery attack.

b. Assess squad personal decontamination procedures.

2. The test soldiers, i.e., the squad, moved into the Assembly Area (AA, point 1) at 0845.

a. The Squad Leader (SL) was given the Operations Order, Appendix D at 0900 by the Tactical Controller (CPT, Gm1C). The SL was also given a PRC 77 radio, a compass, binoculars, an area map, and an M256 Detection Kit. Squad members were given individual decontamination equipment, i.e., two each prototype M58 Skin Decon Training Aids and two each M13 Equipment Decon Kits.

b. LAD paper had been previously affixed to each squad member by Detection and Alarms Division personnel at Range Control. LAD papers had been affixed to the helmet, arm (bicep), wrist and ankle of each soldier and each strip of paper had been marked to denote the trial number, the SPAL attack number, the soldier's assigned serial number and the body location of the strip.

c. The SL gave the Operations Order to the squad. The squad was given 20 minutes to check its equipment and to prepare for the mission. Each member was wearing the chemical protective overgarment, and carried chemical protective gloves and the M17A1 protective mask with hood.

3. The squad moved out of the AA in a squad file in Mission-Oriented Protective Posture (MOPP) 3 at 0930 into the tree line toward the objective as shown in Figure 3F. The control vehicles, with the Tactical Controller (TC), Umpire (UM), observers and data collectors, paralleled the squad on Watson Creek Road.

4. At 0932 when the squad had reached the approximate position denoted as point 3, a prearranged enemy harassing and interdiction (H and I) artillery attack was delivered at point 2 by aggressor forces using M115 Artillery Ground Burst Simulators (AGBS). The squad members donned protective masks and hoods, i.e., assumed MOPP 2. (The test squad should have inspected their LAD papers and, finding no markings, should have concluded that they had not received a persistent agent chemical attack. Hence, they required no decontamination but should have maintained MOPP 2. Whether or not they checked their LAD paper was not observed; however, they did remain in MOPP 2.)

5. As the squad reached the vicinity of point 4, they entered the swamp instead of moving to the right to the west side of Watson Creek Road. The swamp had been designated as a contaminated area (to be avoided) in the Operations Order. However, at the point where the squad entered the swamp, there were no gas markers. The TC contacted the squad by radio, reminded them that they were in a contaminated area, and directed the squad to move out of the swamp toward Watson Creek Road. As the squad moved next to this road, they came into the view of the ED at the CP.

6. The squad continued their approach to the objective, until they reached the knoll at point 5. Here they halted for several minutes to observe the objective. The SL used his M256 kit, observed a negative response and instructed the squad to assume MOPP 3 status. The squad then resumed their approach to the objective in a squad column, fire teams abreast.

7. Shortly after resumption of approach to the objective, in the vicinity of point 6 at 0950, a prearranged enemy H and I artillery attack was delivered at point 7 by aggressor forces using M74 Artillery Airburst Simulators. The squad members, immediately donned protective masks and hoods, i.e., assumed MOPP 2, and the majority assumed a kneeling posture. Approximately 10 seconds after the artillery attack, while they were assuming MOPP 2 status, the squad received a direct SPAL attack. All five SPAL launched and all airburst, however, one SPAL appeared to airburst very low. The squad was in a clearing with virtually no underbrush at the time of the attack. However, the ED's view of the squad from the CP was partially obstructed by the knoll when the attacks were delivered.

8. At this point the exercise was administratively halted by prearranged horn signal. Controller personnel then moved forward, marked squad member's positions with stakes, read and recorded LAD paper markings and removed marked LAD papers. The attack plot is given in Appendix G. As with previous SPAL attacks, LAD paper marks were readily visible. However, fewer squad members received contamination than in previous attacks. Also, those members that did receive contamination appeared to receive less contamination as evidenced by fewer marks on the marked LAD papers. In retrospect, it appears that the combined artillery/SPAL attack was delivered prematurely, i.e., before the squad had reached a downwind point where more members would have received contamination from the SPAL attack.

9. Those LAD papers which had been marked and removed were replaced. The squad was instructed by the UM to move to a position about 150 meters closer to the objective, i.e., to point 8, and to halt, which they did. LAD papers were again inspected and some were found to be marked with contamination, which was evidence that further contamination had been acquired. However, these marked papers were not removed and their identification was not recorded.

10. The squad members were then instructed by the UM to resume the exercise, i.e., to move rapidly to the objective, perform personal decontamination and secure the objective, which they did.

a. Again, problems were observed in the use of Capsule II of the M58 Training Aid. However, some improvement in skin decontamination technique was observed, i.e., use of the buddy system to perform neck decontamination. The members did don their gloves, i.e., assume MOPP 1, after hand decontamination.

b. The M13 Kit was still being used excessively on the over garment creating the "snowman" signature on the users. However, on this occasion the M13 was used in what was judged to be a more effective manner on personal item of equipment, such as webbing and weapons, and on the squad radio.

Following decontamination the exercise concluded.

SYNOPSIS OF TRIAL 4

(Refer to Figure 4F, page 62)

1. In this trial the scenario was a tactical road march, along Maxwell Point Road, following the route shown in Figure 4F. No SPAL were used in this trial. Instead, two sites along the route were selected and precontaminated with the simulant agent, CAST 1, using the 1-1/2 quart M11 Portable Decontamination Apparatus. The purpose of conducting the trial in this manner were to:

a. Make a cursory assessment of the persistence of CAST 1 under field conditions.

b. Demonstrate the feasibility of using an alternative and less expensive means of disseminating CAST 1 where the scenario is based on advance precontamination.

c. Assess trainee response to an alternative method of being exposed to contamination, i.e., without the warning -- visible and audible cues -- associated with direct exposure from SPAL.

2. There was knee to waist high grass and brush at the selected sites along the edges of the road. Approximately 5 meters beyond each side of the road at these sites, there was dense and impenetrable underbrush or swamp. These conditions served to channel the soldiers through the pre-contaminated areas using natural terrain features as opposed to gas markers, etc. Each site was heavily contaminated with about 3 1/2 gallons of CAST 1, applied in a band about 25 meters long and 5 meters wide on each side of the road. The simulant droplets were clearly visible on the vegetation, and there was no dew, which might have had the appearance of simulant, prevalent at the time. The first site was contaminated at about 1300 and the second site was contaminated at about 1330. Ambient air temperature was 70 to 80°F and relative humidity was 70 to 80%.

3. The test soldiers, i.e., the squad, moved into the Assembly Area (AA, point 1) at 1315.

a. The Squad Leader (SL) was given the Operations Order, Appendix D at 1330 by the Tactical Controller (CPT, GmIC). The SL was also given a PRC 77 radio, a compass, binoculars, an area map, and an M256 Detection Kit. Squad members were given individual decontamination equipment, i.e., two each prototype M58 Skin Decon Training Aids and two each M13 Equipment Decon Kits.

b. LAD paper had been previously affixed to each squad member by Detection and alarms Division, personnel at Range Control. LAD papers had been affixed to the helmet, arm (bicep), wrist and ankle of each soldier and each strip of paper had been marked to denote the trial number, the SPAL attack number, the soldier's assigned serial number and the body location of the strip.

c. The SL gave the Operations Order to the squad. The squad was given 20 minutes to check its equipment and to prepare for the mission. Each member was wearing the chemical protective overgarment and carried chemical protective gloves and the M17A1 protective mask with hood.

4. The squad moved out of the AA in a squad column with a fire team on each side of the road in Mission-Oriented Protective Posture (MOPP) 3 at 1400 toward the objective as shown in Figure 4F. The SL and RTO were on the south side of the road. The control vehicles, with the Tactical Controller (TC), Umpire (UM), observers and data collectors, followed about 50 meters behind the squad on the road.

5. The squad passed through the first contaminated site, point 2, without recognizing the contamination on the surroundings or the extensive markings on their LAD papers. Shortly after the last squad member had passed through this site at 1410 the exercise was administratively halted by prearranged horn signal with the squad at approximately point 3.

6. Squad members expressed surprise that the exercise had been halted. They were anticipating a SPAL attack and an attack had not been delivered. At this time they began to recognize that their LAD papers were marked. Controller personnel inspected and recorded LAD paper marks. All members were observed to have heavy contamination markings on the ankle LAD papers and many had less heavy contamination on wrist LAD papers. Some members were taken back to the contaminated site and shown the contamination on the surroundings. Marked LAD papers were removed and replaced. No personal decontamination was performed. The exercise was then resumed by the UM at 1425.

7. At 1430, while the squad was moving to the objective and at about point 4, a 5 round simulated airburst artillery attack was delivered in the vicinity of point 5 using M74 AABS. This attack was not directly visible to the squad, however, the squad immediately responded by assuming MOPP 2 status. After a brief pause, the squad continued toward the objective.

8. Upon reaching the 2nd contaminated site in the vicinity of point 6, several of the leading squad members began to recognize contamination on the vegetation. However, as they were already in masks they were observed to have a difficult time in passing along the alarm. The squad was not halted until the SL and RTO moved into the contaminated area and became aware of the contamination. The SL immediately radioed the TC that they had reached a contaminated area. At this time, the squad was confused as to what, if any, decontamination procedure to use. Two squad members were observed to don their protective gloves. However, neither of these squad members performed skin decontamination on their hands prior to donning the gloves. The squad then rapidly moved out toward the objective.

9. Shortly after the last squad member had passed through this site at 1500 the exercise was administratively halted by prearranged horn signal with the squad at approximately point 7. Controller personnel inspected and recorded LAD paper marks. The same degree of contamination as observed after passage through the first contaminated area was again noted.

10. On questioning the squad (including the SL) most of the members stated that they believed they should have moved out of the contaminated area before performing emergency skin decontamination. However, it was then pointed out to them that they had only approximately 2 minutes to perform skin decontamination after contamination before the onset of casualties. As there is no way of predicting if the unit can find a clean area within 2 minutes and as they were not under direct enemy attack, the correct response was to immediately halt, perform emergency skin decon, and assume a full protective posture, i.e., MOPP 1. The squad should then move out of the contaminated area to a clean area--as determined by use of the M256--to complete decontamination if the mission permits. For administrative reasons, the exercise was terminated at this point, i.e., no decontamination was undertaken.

SYNOPSIS OF TRIAL 5

(Refer to Figure 5F, page 63)

1. In this trial the scenario was a tactical movement to secure and hold an undefended objective as shown in Figure 5F. Two SPAL attacks were delivered, one a direct attack while enroute and the second a precontamination attack on the objective. Artillery simulators, and gas and mine markers were used in this trial for the same reasons as in trial 1. The purposes of conducting the trial in this manner were to:

a. Determine if SPAL could be used to deliver a simulated airburst attack against a moving squad operating in a tactical scenario.

b. Demonstrate that SPAL could be used to precontaminate an area.

c. Assess trainee response to a direct chemical airburst attack and to a direct chemical airburst attack on their objective which they witnessed but which did not contaminate them immediately.

d. Assess squad personal decontamination procedures under stress and nonstress conditions.

2. The test soldiers, i.e., the squad, moved into the Assembly Area (AA, point 1) at 1000.

a. The Squad Leader (SL) was given the Operations Order, Appendix D at 1010 by the Tactical Controller (CPT, CmlC). The SL was also given a PRC 77 radio, a compass, binoculars, an area map, and an M256 Detection Kit. Squad members were given individual decontamination equipment, i.e., two each prototype M58 Skin Decon Training Aid and two each M13 Equipment Decon Kits.

b. LAD paper had been previously affixed to each squad member by Detection and Alarms Division personnel at Range Control. LAD papers had been affixed to the helmet, arm (bicep), wrist and ankle of each soldier and each strip of paper had been marked to denote the trial number, the SPAL attack number, the soldier's assigned serial number and the body location of the strip.

c. The SL gave the Operations Order to the squad. The squad was given 20 minutes to check its equipment and to prepare for the mission. Each member was wearing the chemical protective overgarment, and carried chemical protective gloves and the M17A1 protective mask with hood.

3. The squad moved out of the AA in a squad column, fire teams abreast in MOPP 3 at 1040 towards the objective as shown in Figure SF. The control vehicle, with the TC, UM, observers and data collectors, followed about 50 meters behind the squad. The squad crossed Ricketts Point Road and moved into a copse of trees on a knoll at point 2. By radio, through the TC, the SL requested a fire mission with yellow smoke to mark the objective, point 6. To simulate this fire mission, 4 each M18 Yellow Smoke Grenades were set off on the objective at 1100 by Controller personnel.

4. The squad then continued their approach to the objective, coming into view of the ED at the CP as they left the copse of trees. In the vicinity of point 3, while in MOPP 3, the squad received a direct SPAL attack at 1102. All five SPAL launched and airburst. Squad members were standing in chest high underbrush at the time of the attack, and all members were observed to follow proper masking procedures including transmitting an audible alarm and turning away from the direction of the attack. The squad appeared to begin immediate actions in response to the launch signature of the SPAL. The time from the first sign of recognition until the last member completed donning his mask and hood, and clearing his mask was about 15 seconds.

5. At this point, the exercise was administratively halted by prearranged horn signal. Controller personnel moved into the area, marked squad member positions with stakes, read and recorded LAD paper markings, and removed and collected all marked LAD papers. The attack plot is given in Appendix G. Only one squad member received contamination from the attack and only his wrist paper was marked. The inadequate coverage of the squad resulted from a shift of the wind direction from the Northwest, the prevailing direction when the SPAL line was set up, to the North, the prevailing direction when the SPAL line was fired. When the attack was delivered, Controller personnel were aware of the wind shift and the likely consequence that poor coverage would result. However, the attack was still delivered to demonstrate the importance of wind direction in a chemical attack to the squad.

6. With the exercise still administratively halted the UM instructed the SL to have the squad members perform necessary personal decontamination in place. In addition to the contaminated squad member (number 2) three other members were observed to begin to perform skin decontamination. As these three members had no observable contamination on their LAD papers and persons, they should not have initiated skin decontamination. This was brought to the attention of the SL, who instructed those men to cease decontamination. The contaminated member completed decontamination and assumed MOPP 1 status. (His wrist LAD paper was replaced at this point.) None of the other members were observed to assume MOPP 1 after checking their LAD, however, they should have since there was a positive indication of a persistent agent attack.

7. The tactical exercise was resumed at 1125 when the SL and RTO used the M256 to check for area contamination and obtained a negative response. The SL ordered the squad to assume MOPP 3 and resume movement towards the objective. At 1130, with the squad at approximately point 4, a SPAL attack was delivered from point 5 onto the objective at point 6. All 5 SPAL launched and airburst, however, one SPAL appeared to burst low. At this time the squad saw the SPAL attack and the objective, however, they were still about 300 meters away and downwind from the objective. (Immediately following the SPAL attack, the ED covertly entered the objective and discharged about 1 quart of simulant agent on the surroundings using an M11 Dispenser to assure contamination. In retrospect, this was a hasty and probably unnecessary step, prompted by concern that the objective might have received inadequate contamination under the light and variable winds which prevailed at the time the SPAL was used. Subsequently, when the squad passed through the objective over a considerably broader front than that which had been contaminated with the M11, all members received contamination.)

8. Immediately upon recognition of the attack, squad members turned away and masked, i.e., assumed MOPP 2. The SL contacted the TC and reported that the objective appeared to have received a chemical attack. The TC instructed the SL to continue the mission. The SL determined that none of the squad had received contamination, as evidenced by LAD markings, and then instructed the squad to assume MOPP 1 and continue the approach to the objective.

9. Upon reaching the vicinity of the objective, point 6, one of the leading members of the squad found that the area was contaminated as evidenced by markings on his LAD. The SL reported this situation to the TC, and the TC instructed the SL to have the squad remain in MOPP 1 and secure the objective.

10. As the squad was moving over the objective, a simulated ground burst artillery attack was delivered to their right front, in the vicinity of point 7, by aggressor forces using M115 AGBS. The squad retreated to the southern boundary of the objective, established a defensive perimeter and contacted the TC to advise him of the artillery attack. The TC instructed the squad to hold the objective and to perform emergency decontamination as necessary. The squad did not begin to perform decontamination immediately. Apparently, they were waiting to see if there would be a followup attack. After about 5 minutes, the majority of the squad was observed to begin to perform skin decontamination. (Since the squad had moved through the objective, i.e., a contaminated area, in MOPP 1, skin decontamination was unnecessary. In fact, skin decontamination was hazardous, since gloves were removed. The only emergency decontamination which should have been performed was equipment decontamination with the M13.)

11. At about 1145, while the squad was engaged in decontamination, a small arms aggressor attack was initiated from the tree line, northeast of the objective of point 8. The SL reported this situation to the TC. The TC instructed the squad to clear the immediate area. The squad immediately

began to return small arms fire and to assault the aggressor position. As the squad entered the tree line, the exercise was administratively halted by the prearranged horn signal. The squad was assembled outside of the tree line, and LAD papers were inspected by controllers. All papers, except the helmet papers of two members, showed heavy contamination. For administrative reasons, the exercise was terminated at this point, i.e., no decontamination was undertaken.

APPENDIX F

TRIAL PLOTS

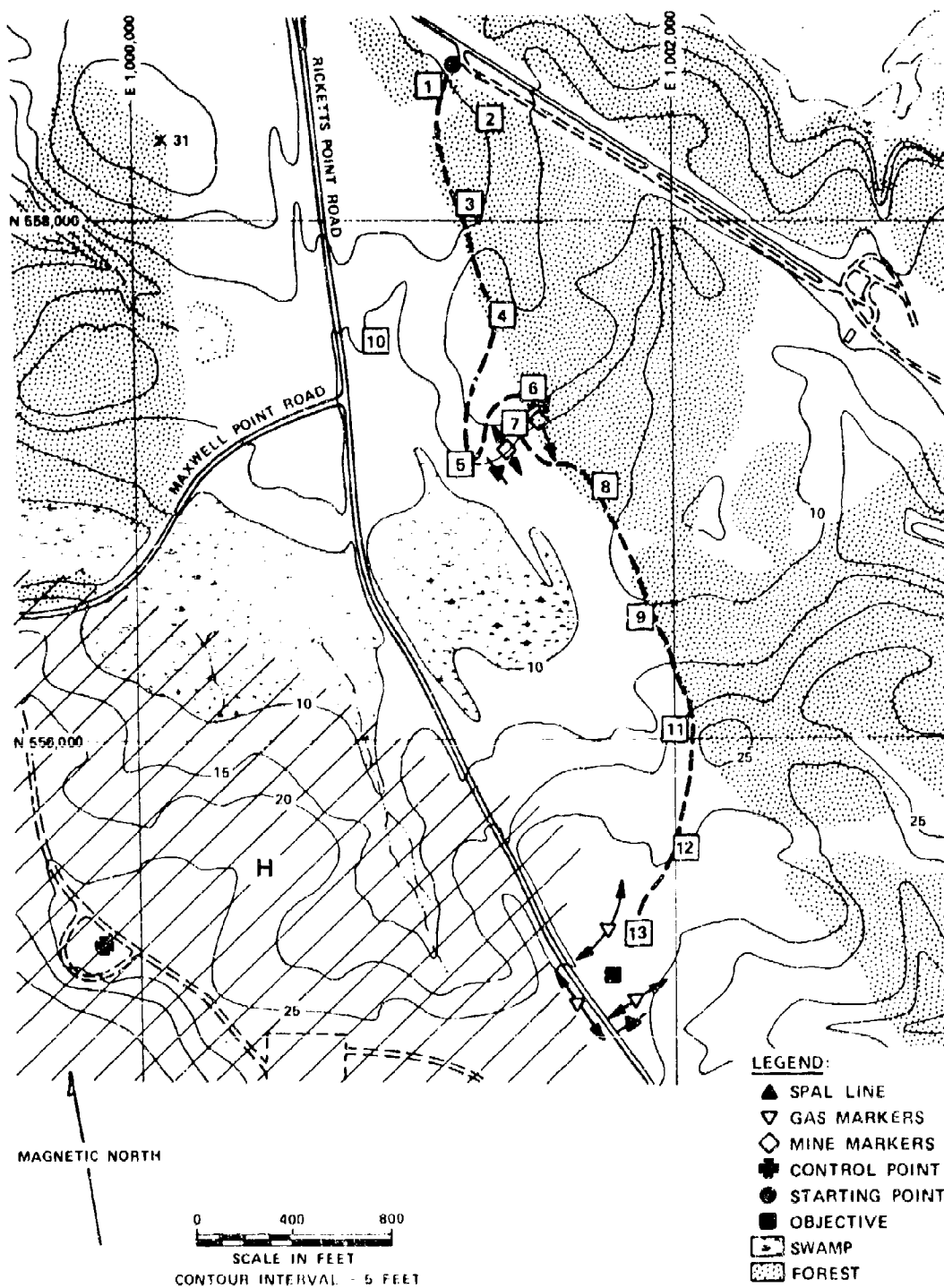


Figure 1F. Trial Number 1.

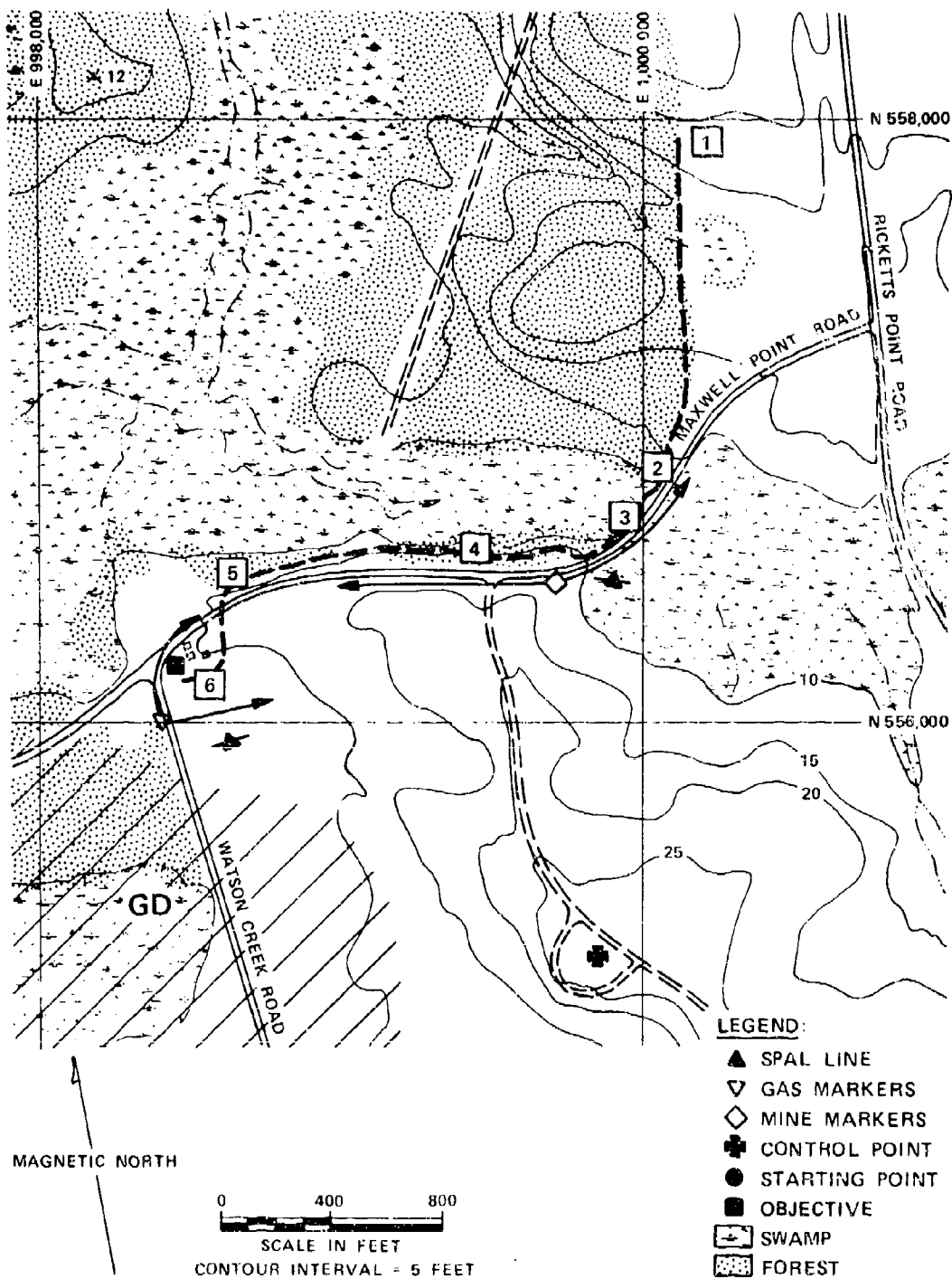


Figure 2F. Trial Number 2.

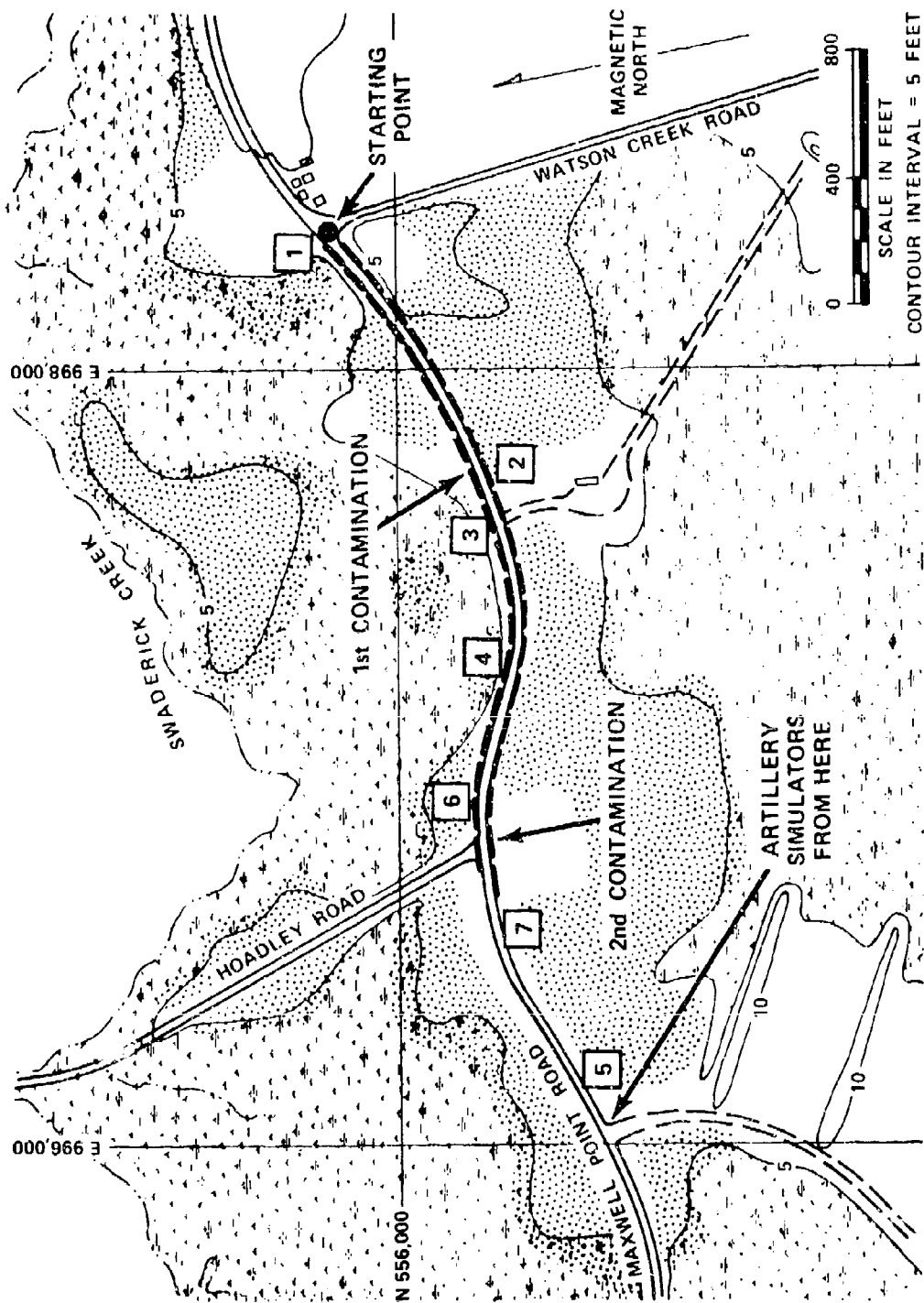


Figure 4F. Trial Number 4.

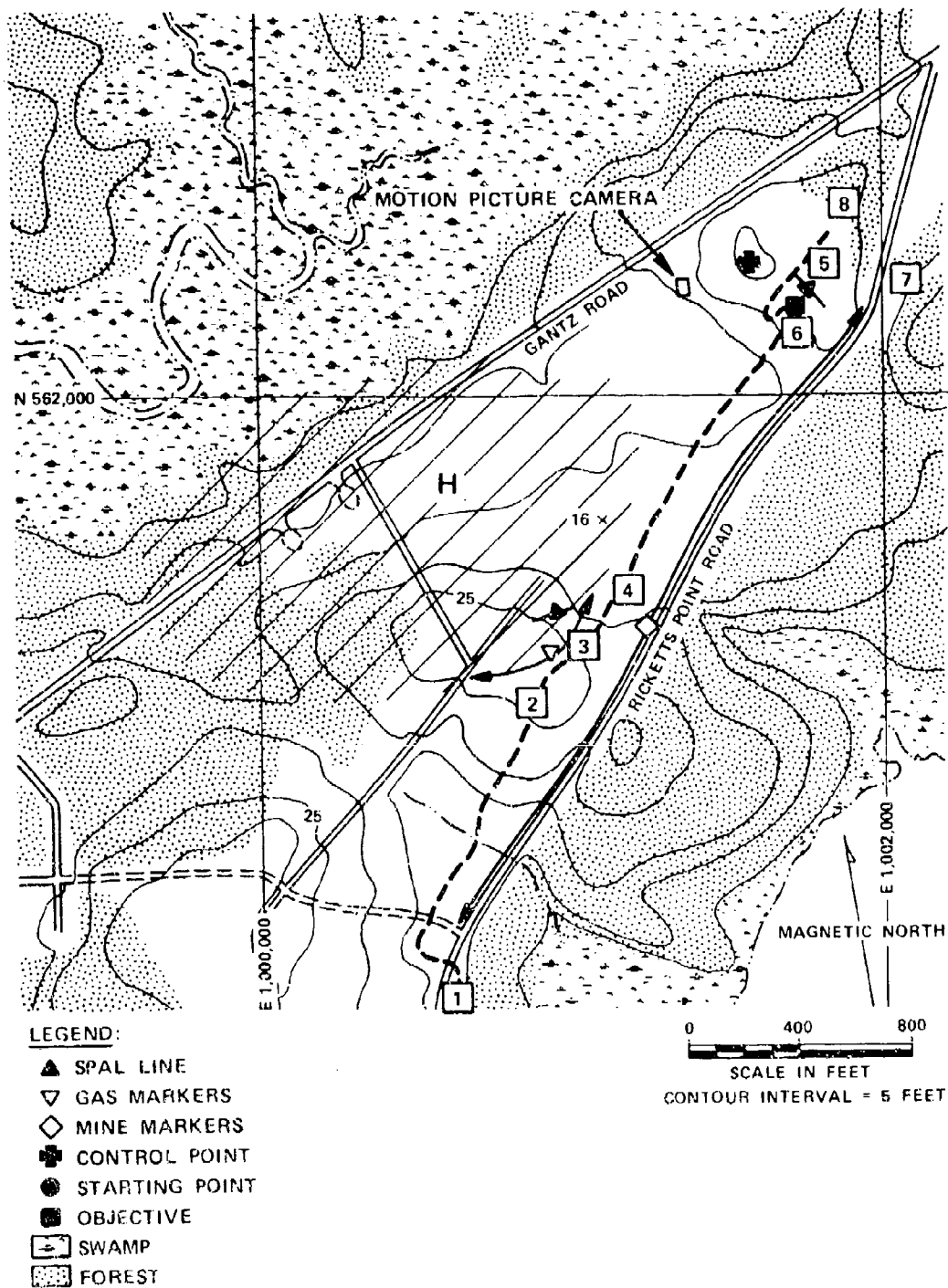


Figure 5F. Trial Number 5.

APPENDIX G

ATTACK PLOTS

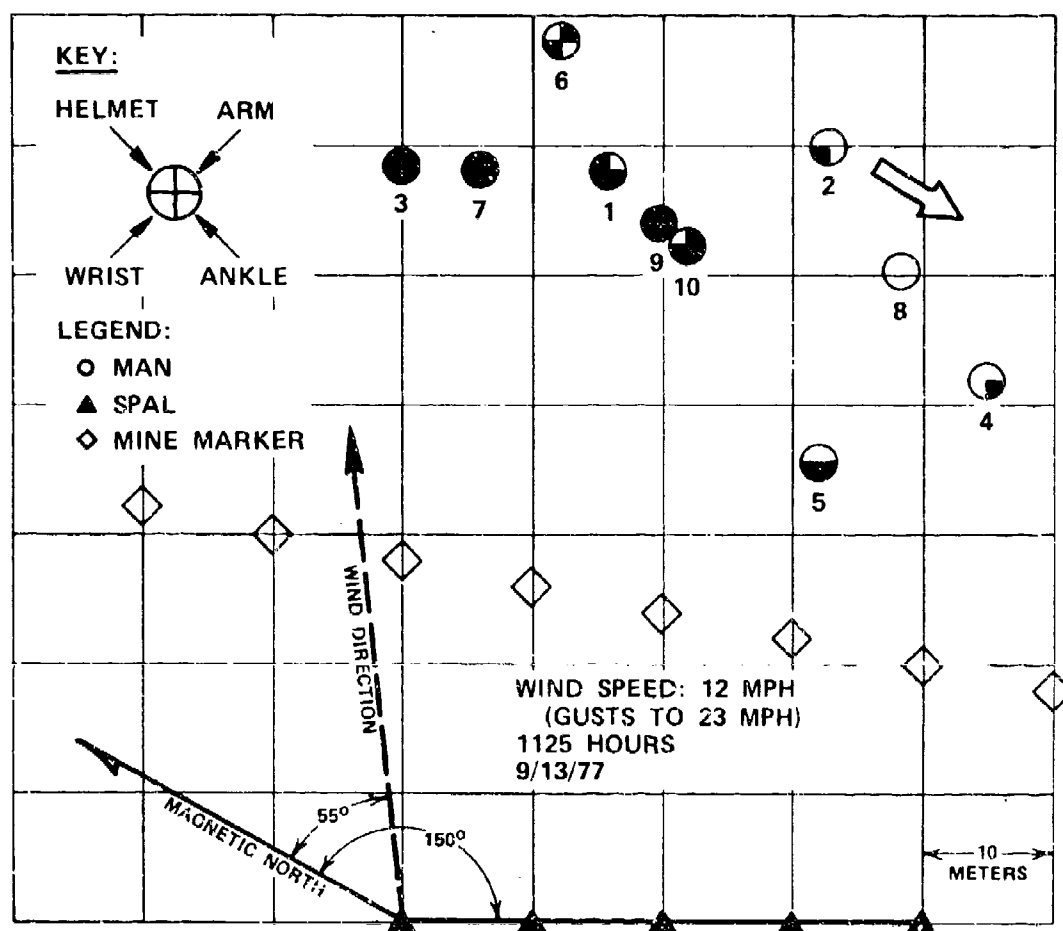


Figure 1G. Trial Number 1, Attack Number 1.

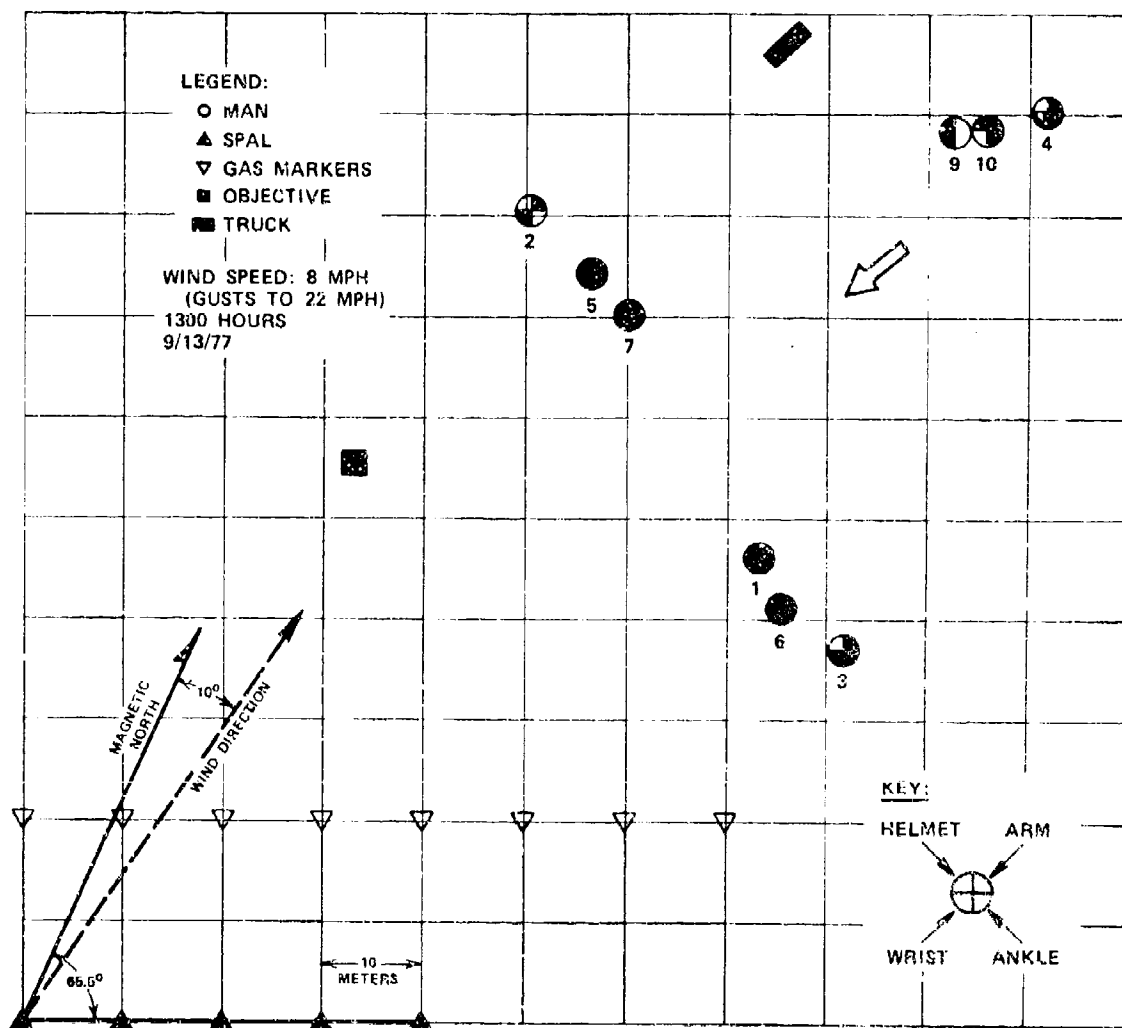


Figure 2G. Trial Number 1, Attack Number 2.

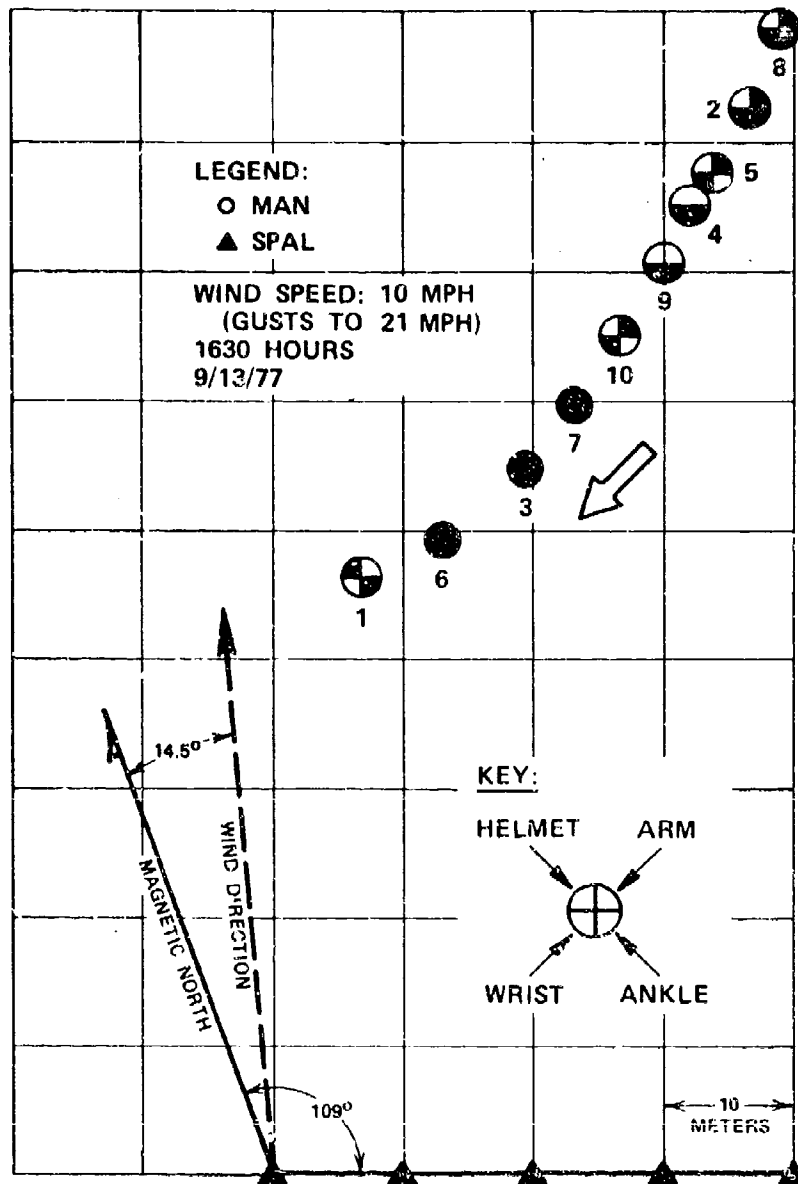


Figure 3G. Trial Number 2, Attack Number 1.

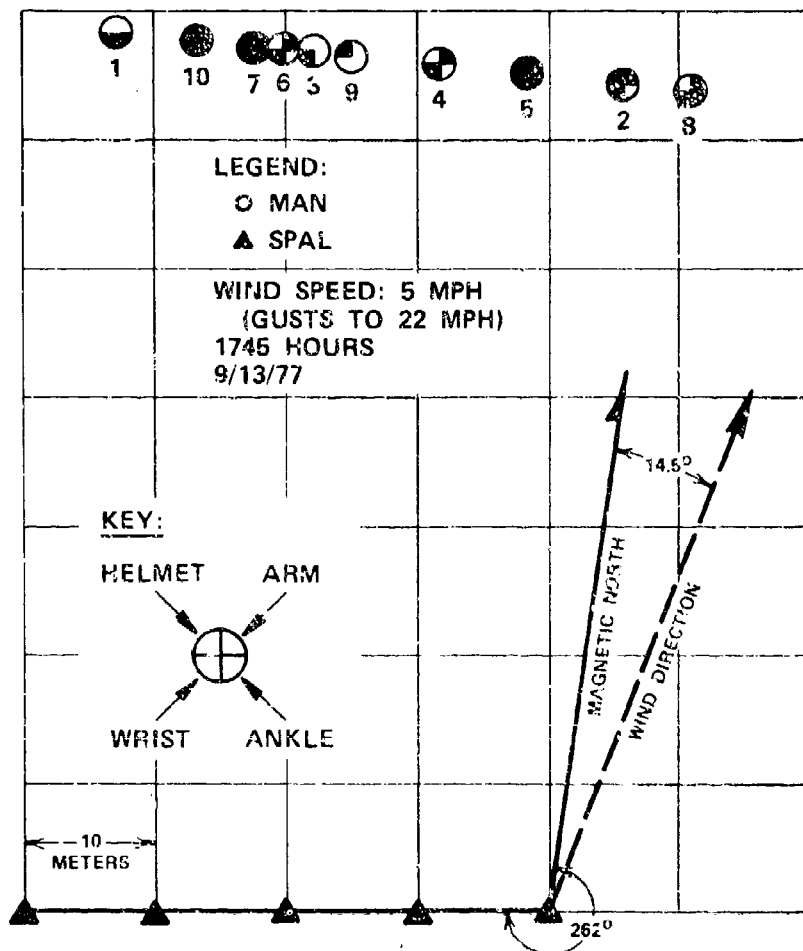
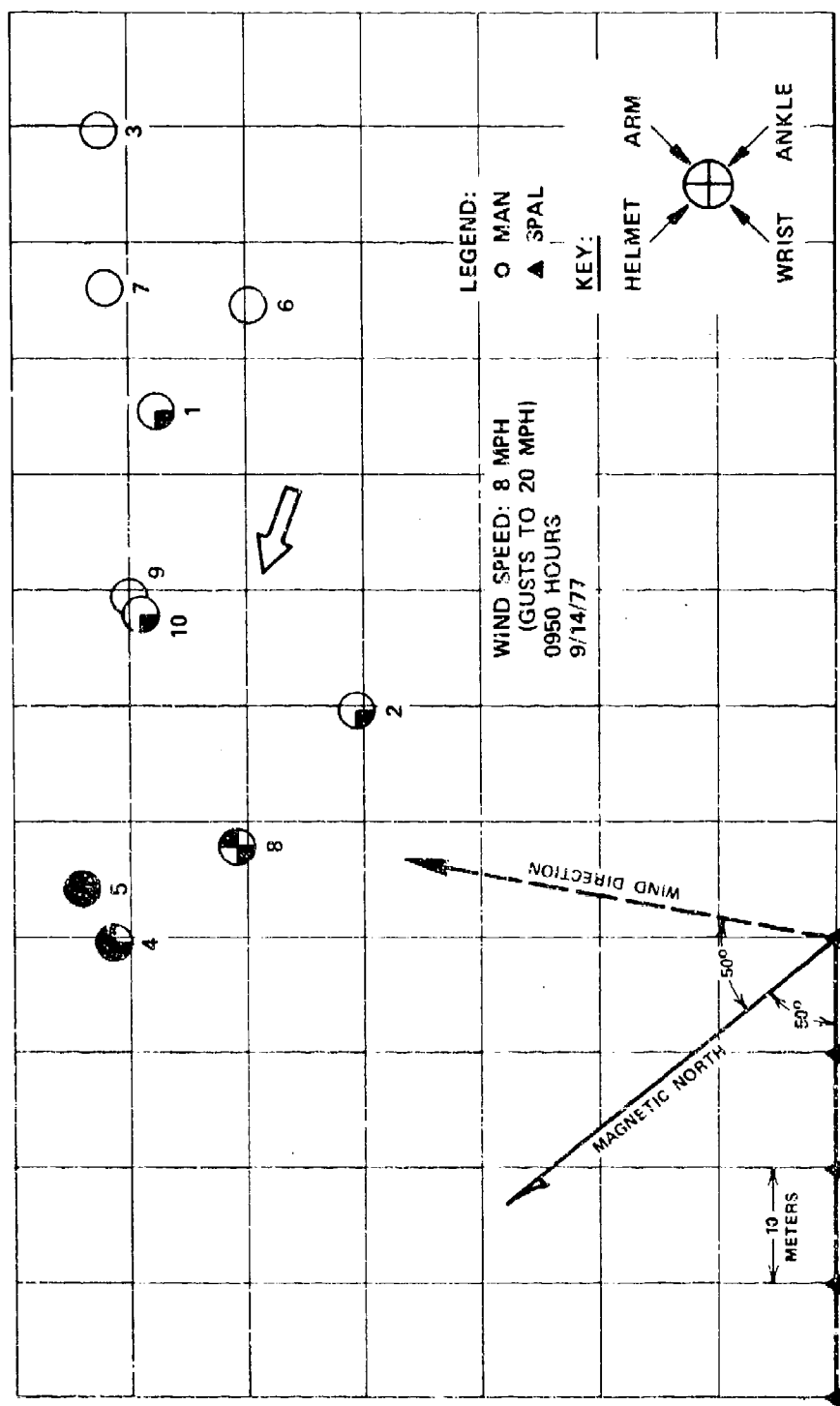


Figure 4G. Trial Number 2, Attack Number 2.



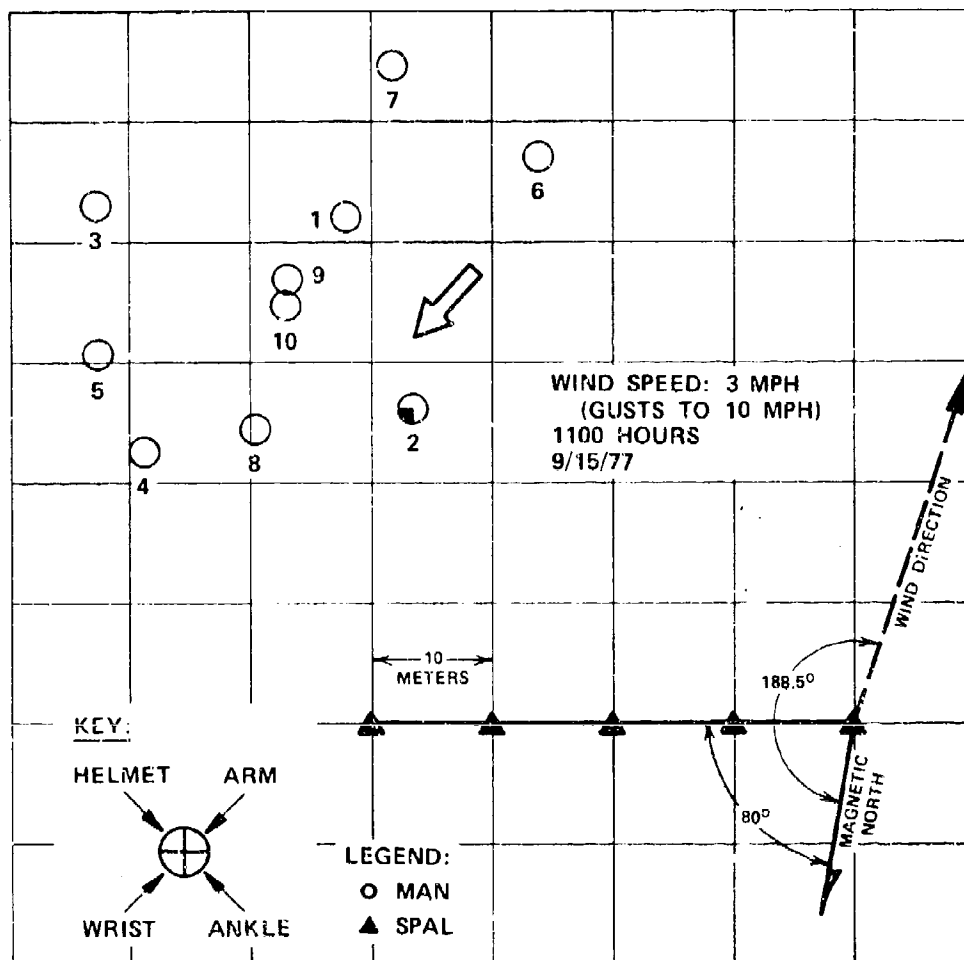


Figure 6G. Trial Number 5, Attack Number 1.

APPENDIX H
UMPIRE'S OBSERVATIONS

BY

Steven J. Wade, CPT, CmlC

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ATSL-CLC-O

30 September 1977

MEMORANDUM FOR RECORD

SUBJECT: Observations on the Simulator, Projectile, Airburst, Liquid
(SPAL) Operational Feasibility Test (OFT)

1. The undersigned participated in the SPAL OFT as umpire. Duties included maintaining close visual contact with the test infantry squad at all times, insuring the squad was never endangered by the SPAL firing, and monitoring the route and progress of the squad through each course leg.
2. The objective of the OFT was to determine the feasibility and usefulness of SPAL with PEG-200 as a training device for simulating a "toxic rain" attack in a training environment. An infantry squad of 10 men was used for the test. Five course legs were run, each over different terrain and with different missions and objectives. See Annex A for test chronology and course leg descriptions. For the test, the squad was canalized by simulated minefields and chemical contamination to insure they moved in range of the SPAL.
3. In addition to the SPAL, several other new items were used and doctrine developments were explored. These included the use of a 10 wt % solution of water in polyethylene glycol-200 (PEG-200), a new Surgeon General approved liquid agent simulant, XM9 Liquid Agent Detector (LAD) paper, a developmental item designed to be worn by the individual soldier to detect liquid chemical agents, the use of the M58 Skin Decontaminating Training Kit, the use of the M256 Detector Kit, and exploratory doctrine on the use of the Skin Decontaminating Kit to decontaminate the head, neck, hair and hands. Wherever possible, every attempt was made to give the squad leader maximum latitude in conducting each course leg in an operationally and tactically correct manner.
4. The SPAL system, when filled with PEG-200, provides very good dispersion and simulated contamination over a large area, particularly when the SPAL is employed in series of five or more individual launchers. However, the SPAL does not simulate a high altitude "toxic rain" attack by any stretch of the imagination. The bottles explode at 10-20 meters in the air, releasing the simulant cloud and a puff of smoke. The signatures of the simulant dissemination is clear and easily recognizable to any who see it. Because of this, the SPAL is an excellent airburst chemical artillery attack simulator and the functioning of the SPAL is almost identical to what could be expected in an airburst artillery attack. However, the SPAL does require advanced planning

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ATSL-CLC-0

30 September 1977

SUBJECT: Observations on the Simulator, Projectile, Airburst, Liquid
(SPAL) Operational Feasibility Test (OFT)

and time to emplace properly. During exercises and training tests, this may be a drawback in its use. Additionally, the SPAL emplacement is extremely important because, as clearly demonstrated in one test, the SPAL depends upon the wind for best dispersion. The use of the SPAL without careful attention to wind direction and speed may result in the simulated attack being entirely ineffective. A modified SPAL system that requires minimal emplacement time and can be shifted to account for wind direction would be desirable and a distinct improvement.

5. The PEG-200 simulant appears to be a good liquid agent simulant. It does not, in its present form, simulate a thickened agent. The PEG-200 gives an almost immediate reaction with the LAD paper and reacts positively with the M8 detector paper. The major drawbacks with PEG-200 are that its vapors do not activate the M256 Chemical Agent Detector Kit or M8 Automatic Chemical Agent Alarm and it does not challenge the mask. There is no penalty to an individual if he masks incorrectly or too slowly upon dissemination of PEG-200. Perhaps mixing the PEG-200 with CS or another simulant will overcome this deficiency. (This idea has been recently supported by the Academy of Health Sciences.)

6. The XM9 LAD paper, which is a developmental item early in its life cycle, has some drawbacks which must be corrected before it will be fully useful. The paper has an encapsulated dye coating on one side and an adhesive substance on the other. The dye gives an immediate red color change when it comes into contact with PEG-200 and, presumably, liquid chemical agents. The adhesive backing will not adhere to clothing due to the stiffness and lack of flexibility of the paper. Consequently, the LAD paper must be wrapped completely around the arm or leg and stuck to itself to insure it stays on the individual. The LAD paper itself is light grey in color. This enables the paper to be easily read, but also marks the wearer by being totally incompatible with any camouflage. Bumping or scraping the paper against a hard object can result in a red streak or spot on the paper. Unless the individual is familiar with the paper and the indications it gives, this scuffing due to mechanical action may give a false reading to the individual. Finally, the dye used in the LAD paper has been determined to be mutagenic and requires the use of impermeable gloves to handle the paper. This will be unacceptable if the item, when fielded, must be handled only with gloves in a field environment. Also, disposal of used LAD paper, since it may be classified as a hazardous material, may complicate training use to the point where it will not be used at all for training because of these drawbacks.

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30 September 1977

SUBJECT: Observations on the Simulator, Projectile, Airburst, Liquid
(SPAL) Operational Feasibility Test (OFT)

7. Miscellaneous Observations.

a. Protective overgarments. The overgarments bore up well and showed no noticeable tears, rips, etc. The pockets on the jacket are unusable when load-bearing equipment (LBE) is worn. Since wearing LBE is mandatory for the combat soldier, the jacket pockets are essentially useless for anything more than paper and pencils. One suggestion is to add cargo packets on the sides of the overgarment trousers. They would be accessible when wearing LBE, would not interfere with other gear, and could readily be used to carry NBC defense items, such as gloves, M258 kits, M13 kits, etc.

b. M58 Training Kit. Most squad members had seen the M258/M58 kits previously, usually in their Expert Infantrymen Badge testing. However, in many cases, individuals consistently demonstrated methods that, if used, would result in merely spreading contamination on the skin, rather than removing it. When proper methods were demonstrated, one or two individuals remarked that they had noticed that before, but "the book" had said otherwise. It is recommended that current training manuals be reviewed to insure that the step-by-step use of the kit is fully explained for every situation which may be encountered.

c. Use of the M58 Training Kit. Recent field reports have indicated problems in breaking the glass vial inside the solution #2 container of the M58 and M258 kits. This problem also surfaced when the squad collectively attempted to use the M58 kit for the first time. However, after using the kit several times in a tactical environment, no further difficulties were reported or observed in using the kit. It appears that the major problem is that the personnel had little or no experience in using the #2 container before. They knew how to use it, but had never actually done it before. The solution to this problem is to ensure personnel have an opportunity to use the kit and become familiar with it. The current allocation of the M58 kit is one per man per training year. This allocation should be revised to at least four kits per man per year. This would allow one kit for familiarization, one kit for individual testing and two kits for use in annual FTXs and ARTEPs for realistic NBC training.

d. Useability of the M258 Kit. In an active NBC environment, it is conceivable that an individual may decontaminate himself several times in a period of one or two days. As presently configured, the M258 is a one-use kit. The current product improvement program for the M258 should address this problem and hopefully field a reuseable or multiple use item as soon as

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30 September 1977

SUBJECT: Observations on the Simulator, Projectile, Airburst, Liquid
(SPAL) Operational Feasibility Test (OFT)

possible. The idea of using a disposable pre-moistened towel seems to be a good idea, especially if it is packaged so one individual can carry several at one time and it consumes no more space or weight than the current M258 kit.

1 Incl
Annex A

/ts/
STEVEN J. WADE
CPT, CmLC
Evaluation Officer

ANNEX A
TEST SCENARIOS
SPAL OFT

1. 1st Day. Two legs were run on the first day. The first course leg began in a wooded area, and doglegged across a brushy area to attack an "enemy held" observation post. The mission was to take the OP. The squad was attacked with SPALs (five each) as they moved along the edge of the forest and as they attacked the OP across an open field covered with chest-high grass. On both of these attacks, well over 50% of the personnel had indications on the LAD paper that the simulant had hit them. The second course leg, in the afternoon, involved moving through a forest, past a swamp, and securing a road junction. Personnel were attacked with SPALs as they moved along a road shoulder to avoid the swamp and as they moved beside a fence to consolidate on the objective. In both cases, over 75% of the men were hit by the simulant, as indicated by the LAD paper.

2. 2d Day. Two course legs were run on the second day. The first leg ran from a wooded area, skirted a swamp and then doglegged through a clear area to the objective of two observation towers. The squad was attacked as they crossed the clear area just before the objective. When the SPAL was launched, the squad had just completed masking in response to a simulated artillery attack. Less than 50% of the squad was hit by the simulant during the attack. In the afternoon, the squad conducted a tactical road march down a paved road to move forward and reinforce an infantry company. Both sides of the road were contaminated with PEG-200 in two separate locations approximately one hour before the squad entered the area. The squad did not notice the contamination at all in the first area and all squad members were heavily contaminated from approximately waist-level down. Some squad members had contamination on their shoulders and helmets from touching contaminated vegetation and branches. The squad was completely surprised when shown the contamination on their LAD paper. One squad member noticed and reported contamination to the squad leader while moving through the second area of contamination. However, the contamination was not noticed until every squad member had been recontaminated, as revealed by the LAD paper which they wore.

3. 3d Day. One leg was run on the third day. The squad moved along a woodline, across a road, through a brushy area to a series of trenches near another woodline, which was the objective. The first SPAL attack was initiated as the squad moved through the brushy area. Because of a shift in the light winds when the squad moved into the attack zone, only one man was slightly contaminated. However, several squad members initiated decontamination automatically and had to be stopped by the squad leader. The squad observed, as they approached, their objective being contaminated by the SPAL. They assumed full protective posture and reported the contamination when they occupied the objective. Finally, the squad was attacked by aggressors at the objective and had to organize and counterattack over contaminated terrain while in full protective clothing. All squad members showed signs of contamination at the conclusion of the exercise.

APPENDIX I

OBSERVATIONS ON DECONTAMINATION PERFORMANCE

BY

Millard M. Mershon
Biomedical Laboratory
Chemical Systems Laboratory

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DRDAR-CLL-MM

9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operational Feasibility Test (OFT)

1. A request for Chemical Systems Laboratory comment on proposed usage of M258 Skin Decontamination Kits (Reference: Letter, ATSL-CD-MSC, USAOC&S, 7 June 1977, Subject: Request for Information) was generated in part for guidance in planning usage of M58 Skin Decontamination Training Aids in subject test. Biomedical Laboratory participation in attempts to draft a reply (Reference: Memorandum for Record, DRDAR-CLL-MM, Pathobiology Branch, 8 July 1977, Subject: Response to 7 June Letter From USAOC&S) led to the suggestion by 1LT Lindsey that this laboratory furnish an observer of the subject test. This memo reports observations made during the period 12-15 September 1977 and confirmed whenever possible by review of film and data available in December 1977.
2. On Monday, 12 September 1977, 10 combat-ready soldiers of the 82nd Airborne Division were briefed on subject test to be conducted during the three days to follow. This briefing included display of, discussion of, and initial practice with standard combat gear and chemical protective materiel, including M13 Decontaminating and Reimpregnating Kits and Prototype M58 Skin Decontamination Training Aids, hereafter called M58 kits. Each man was issued one M58 kit to be used after instructors received satisfactory descriptions of intended use from each soldier.
3. Each M58 kit consists of a plastic case that contains two vinyl chloride capsules partially filled with rubbing alcohol. Capsule I is a cylinder with spherical ends, of 3-cm diameter and 10-cm length. Capsule II is of similar length but is shaped as a rectangular solid with rounded corners and 3 x 5-cm cross-section. A semicylindrical glass ampule containing table salt floats in the alcohol solution of Capsule II. This ampule has a spherical bulge to facilitate breaking inside the capsule at time of use. Components of this prototype kit differ from standard M58 and M258 in several ways. The standard ampules are cylindrical with a circumferential score to aid breakage. Prototype capsules are formed by fusing two symmetrical shells. M258 capsules are blown like bottles so that one end must be sealed with a flat lid that is cemented in place. Prototype capsules are of uniform wall thickness but the blown bottles have thicker walls at each end. A thin steel strap with a sharp pointed (30°) end is rivetted to each prototype case cover for use in piercing capsules. Standard M58 and M258 kits have a roofing nail point imbedded in the plastic covers for the same purpose.

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MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operational Feasibility Test (OFT)

4. Practice use of the M58 was initiated by an instructor giving a "gas" alarm. This was followed by some fumbling during removal of capsules from cases and orientation of the piercing point to open capsule 1. Typical use of gauze pads wet with M58 solution was to blot hands, face and neck. Instructors reminded the soldiers to wipe away from the body.

5. Nine of 10 men had initial difficulty in breaking the glass ampule of the M58 II capsule. Seven of 10 shattered the capsule without salvaging enough content for successful decontamination. Difficulties were of three kinds: (a) initial blows too weak, followed by a shattering blow; (b) holding capsule in fingers which cushioned blows; or (c) failure to select a hard corner to strike against. The following compilation of observations and delayed recollections list the resistant object, the number of attempts made against that object (in parentheses) and the outcome [in brackets]:

- (a) tree (3), entrenching tool (2) [capsule emptied, glass intact];
- (b) entrenching tool (2) [broke both capsule and glass, lost most of fluid];
- (c) entrenching tool (2), knee (2), entrenching tool on knee (1) [successful];
- (d) tree (6), helmet (2) [shattered capsule, glass intact];
- (e) knee (3), helmet (2), tree (2), helmet + helmet (1) [shattered both];
- (f) helmet (3) [successful after 2 weak blows];
- (g) tree (2), entrenching tool (3), entrenching tool vs helmet (1), [shattered both];
- (h) knee (3), helmet (1) [lost 3/4 of fluid];
- (i) knee (1) [lost little fluid; successful];
- (j) knee (2), entrenching tool vs knee (1) [broke both, lost fluid].

6. The results observed and comments by the men suggest that:

- (a) none of the men had practiced with the M58 kit;
- (b) demonstrations did not convey appropriate methods for breaking the ampule;

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9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operation Feasibility
Test (OFT)

(c) neither the mechanics of striking against a corner nor between two unyielding objects were taught;

(d) the required amount of force varied with the method and was only learned by experience;

(e) under stress conditions the M258 II capsule may be unreliable.

7. Other observations made during the practice session include:

(a) a notation that 9 of 10 helmets went on the ground during mark drill, only the helmet held between the knees with the crown upward is likely to be free of contamination by liquid agents;

(b) one hood was severely torn during donning. Inspection showed the origin of the tear to be where a drawstring passed through a loop directly back of the head. This loop is reinforced only by a dime-sized patch of thin material, while other loops are fastened to sewn seams. Another similar tear was observed during the first subsequent exercise and two other hoods had abrasion holes later. Such results suggest that hoods may be unreliable.

(c) Troopers were confused about the proper use of M13 and M58 kits when both were available. One man attributed this confusion to separation of training into "stations" where each kit was demonstrated separately.

8. Use of M58 kits were observed in only 3 of the 7 SPAL attacks delivered in the OFT. In each case 5 SPAL were airburst about 10 meters apart in a line upwind of the troops. Each SPAL was loaded with a mixture of polyethylene glycol 200 diluted with 10% water by weight. This mixture is called CAST 1 (Chemical, Agent Simulant: Training 1). An umpire allowed time for masking; then used a horn signal to "freeze" actions for inspection of contamination by the CAST 1 and for removal of Liquid Agent Detector (LAD) paper. Troops resumed action with individual use of M58 kits to decontaminate hands, followed by "buddy" use of M58 material to reach under the purposely unsecured hood for decontamination of the neck, ears and chin. Buddy use of M13 dusting bags on hoods, overgarments and equipment was the final step in decontamination. Discarded M58 kit materials were collected for later study and notes were made on soldier use of the materials.

9. The first SPAL attack, designated Trial 1, Attack 1, occurred late in the morning of 13 September while troopers were dispersed inside a thinly wooded area of tall trees and sparse undergrowth. The helmets of four men were moderately speckled with simulant. One man later

DRDAR-CLL-MM

9 December 1977

MEMORANDUM FOR RECORD SUBJECT: Decontamination Performance During SPAL Operation Feasibility Test (OFT)

reported that he felt droplets against his face before he could mask. Another man masked rapidly; then turned toward the SPAL line in time to receive numerous droplets on the lenses of his mask.

10. Performance with M58 capsules was noticeably improved as compared with practice results on the previous day. Only 3 of 10 soldiers failed to break the glass ampule, vs 7 of 10 failures on the practice trial. However, 3 of the soldiers damaged their capsules and lost much of the M258 II solution after breaking the ampules. These 10 men reported use of 13 different methods and a total of 21 different attempts to break the ampules in this exercise. However, this represents improvement over use of 21 different methods and 45 separate attempts to break ampules reported during the practice exercise.

11. The second decontamination exercise followed Trial 2, Attack 1. This attack occurred late in the afternoon of 13 September, as the soldiers formed a long line along a road ditch with negligible cover. Observers noticed the impact of simulant droplets on their faces. Similarly, 4 of the 10 soldiers reported facial impact of droplets. These men had simulant speckling on their helmets and overgarments, but not on their hoods. At least one of the other soldiers had learned to turn away from the sound of the SPAL, thereby preventing facial exposure. There was no way to observe possible contamination of hair, neck and ears or webbing of the mask in these men; therefore, it is not clear whether simulant droplets struck before or after removal of the helmet. It is apparent that 4 men experienced facial contamination before they could unpack the mask and place it on the face. It follows that the effect of masking under these conditions is to trap simulant within the airspace and under the peripheral seal of the mask. Similarly, deployment of the hood served to trap any simulant that may have struck elsewhere on the head or neck. The absence of contamination on the outside of hoods suggests that any droplets not collected on the helmet were covered by the hood. Hazards from both liquid and vapor would be increased if toxic agents were present.

12. Additional improvement in use of M58 II capsules was noted in this second decontamination exercise. All ampules were fractured but only one capsule was shattered by excessive force (between a fist and the entrenching tool). Only one man reported need for a second attempt to break the ampule.

13. The third decontamination exercise occurred after OFT Trial 3, Attack 1. This SPAL attack took place in an open field on Wednesday morning 14 September. Only 2 men received slight positive LAD indications on the helmet and some were not hit at all. Decontamination performance was less desirable than on the previous occasion. One soldier broke only the small tip of the ampule and two others shattered the capsule, losing most of the fluid. Two other soldiers apparently salvaged most of their fluid, although recovered capsules were broken at one end, rather than showing signs of being pierced. Five of the 10 men required 2 attempts to break the glass in this trial.

DRDAR-CLL-MM

9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operation Feasibility Test (OFT)

14. The final decontamination exercise was associated with Trial 5 on 15 September. Recovery of used kit materials was not possible after this exercise because it involved an aggressor attack during decontamination. This was a small-arms-fire aggressor attack; not a SPAL or artillery attack. The following observations reflect differences of decontamination rates. They may suggest differing responses of the soldiers to instructions stating that decontamination is optional if LAD paper is negative. However, the following LAD observations only reflect helmet exposures:

#1 LAD +; kit deployed but not in use at attack. Capsules and gauze stuffed into case before responding to attack.

#2 LD +; M58 use completed, using M13 on buddy at attack.

#3 LAD +; M58 being used on neck by buddy at attack.

#4 LAD +; using M58 I, dropped all material at attack.

#5 LAD +; sharing M58 kit with #3 and #4 at attack.

#6 LAD -; no decontamination.

#7 LAD +; performing decontamination of buddy.

#8 LAD -; had finished use of both M58 I and M58 II; had gloves back on at attack.

#9 LAD +; finished with M58 I on hands and neck at attack; put on gloves; did not use M58 II after attack.

#10 LAD +; had pierced M58 I; dropped at attack.

15. The above oral reports obtained at the end of the exercise show only one instance of salvage (for future use) of M58 components. They reveal the discovery by one fire team (#3, 4 and 5) that three men can share on M58 kit if only the hands and neck are to be decontaminated. Other notations made at this time show that two men were unwisely using the M13 kit with bare hands on men with LAD + indications of contamination. The undesirable tendency of M13 powder to leave highly visible white markings was also observed.

16. Tabulation of methods used to break the M58 ampule show only 2 of 10 men who continued use of the method found successful during their practice run. One man used his entrenching tool as an anvil; the other man used his helmet the same way. These were the most popular methods, each being used in 13 of 40 instances. Trees were next most popular, with 8 of 40 uses. Knees were used only during the practice session, although half of the men used their knees then. One man regularly broke ampules between the clip and receiver of his rifle.

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9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operation Feasibility
Test (OFT)

Some men held the capsule in their fingers; others cupped them so that the heel of the hand was behind the capsule at impact. Two soldiers smashed the ampule between their rifle butts and a tree. Another used his entrenching tool as a hammer. The soldier who carried the detector kit used that as an anvil but he apparently gripped the capsule in his hand to strike the end of the capsule, breaking only the tip of the ampule. Most of the men used a different method in each consecutive attempt. None demonstrated any evidence that they had been trained to break ampules by a specified method. Nine of 10 soldiers attempted to pierce capsule I at the end where a 5-mm-diameter patch was placed over the filling hole. They apparently perceived this as a target which they attempted to pierce and usually did. Unbroken specimens of capsule II usually are pierced on the flattened surface adjacent to the target spot.

17. Observations of cleansing procedures suggest that (a) coverage was neither systematic nor thorough; (b) cleansing under the hood was erratic and limited to the back of the neck in most cases; (c) training with the M13 kit leads men to blot with the M58 kit; (d) the men had little appreciation of the possibility of recontamination (for instance, men decontaminating the neck of a buddy could easily pick up contamination from the hood on their own hands, which were not recleaned). Observations (a), (b), and (c) reveal that these troops have no concept of the adhesiveness of thickened GD, nor of the laboratory experience that repeated and firm rubbing with coarse gauze is required to remove thickened GD. Neither do they appear to understand that M258 solutions do not dissolve the thickener so that simple contact with the agent does not result in decontamination; agent must be physically removed.

18. Several interesting observations were made by the squad members during a debriefing exercise on the afternoon of 15 September. Some comments involved training: (a) confusion exists about when or how to use the scraper; (b) M13 (blot and remove) directions are confused with M58 (wipe away from the body) directions. A poll revealed that 5 of 10 men blotted with M58 solutions; 2 of 10 said they did some of each. (c) Confusion exists on when to decontaminate or not to do so with various situations, amounts of exposure, attack conditions, open vs closed overgarments, cold- vs hot-weather exposures, etc. (d) A need for training beyond infantry basic experience was expressed, together with criticism of the present methods of demonstration at separate stations and (e) training to turn away from the wind or explosion was recommended.

19. Squad members had comments during the debriefing on decontamination methods, as follows: (a) methods should be revised to allow for inability to see, except at arm's length, through M-17 mask lenses; (b) it is easier to squirt solutions onto hands than to wet gauze first; (c) an aerosol or squeezable container would be appreciated; and (d) decontamination beneath the hood is

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9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operation Feasibility
Test (OFT)

necessary (if the hood is unsecured) because it tends to ride up and expose the hairline. Seven of 10 squad members said that decontamination under the hood is worthwhile.

20. Protective equipment received the following comments during the debriefing: (a) the overgarment should have a collar to provide head protection when one turns away from the exposure source; (b) gloves are difficult to don and should have Velcro strips or zippers; (c) hoods tend to hang up; therefore should have Velcro or zippers; (d) overgarments should have more pockets for storage of decontaminant material, preferably on the sides of the pants; (e) tucked nose cups in the M17 mask produce fogged lenses and occur too frequently; (f) the point man should have a detector or extra LAD paper.

21. Potential improvements in training, doctrine and protective equipment are suggested by analysis of results summarized below. A facial exposure was reported by one of 3 or 4 men at the edge of cover on the morning of 13 September. That afternoon 4 or 5 men with LAD + helmets were aware of droplets on the face. Two more men reported facial exposures during the last attack on the same date. Such reports do not include insensible exposures to fine droplets or contamination of hair and mask or hood surfaces that become occluded by the hood. In the cases observed each man would have received a simulated lethal dose as drops on skin, which were then occluded, enclosed by the M17 mask. The use observed of the hood tends to preclude any attempt to remove the mask for facial decontamination, even if agent droplets are felt at impact. Skin prophylaxis might improve the prognosis if a suitable detoxifying reagent is incorporated as in M5 ointment for protection against mustard or V agents. However, skin prophylaxis is not designed to protect hair that collects agent while the helmet is off.

22. The learning point set forth by the facial exposures observed is that the head and neck must be completely protected before agent contamination occurs. This exercise reinforces the idea that combat troops exposed to chemical, rocket, artillery or mine attacks can ill afford to remove their helmets or take time to don masks and hoods.

23. Reconsideration of potential benefits of the M258 Skin Decontamination Kit and increased emphasis on physical protection appear to be indicated by the above results. Unless available shelter permits the soldier to take immediate cover without masking, about all that the M258 kit can provide under the conditions observed is capability to decontaminate the hands. If the overgarment is not worn it may have value for decontamination of other exposed skin such as areas or skin exposed by tears in the undergarment.

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9 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Decontamination Performance During SPAL Operation Feasibility
Test (OFT)

24. Although different results are likely with standard M58 or M258 capsules, a question is raised about a possible requirement to replace the existing hardware with items that do not require exceptional skill by novices. Meanwhile, human factor studies to determine the most foolproof use of the existing kit are clearly indicated. Likewise, it is obvious that training should include practice with M58 Skin Decontamination Training Aid Kits under simulated combat conditions, if possible. Ideally, training should include use of a stimulant that will reveal poor cleansing, as demonstrated by residues of food color, riot-control agent sensations, or other indications that will reveal poor protection and reinforce proper responses.

25. Several options are available for prevention of facial exposures and agent occlusion in the event of surprise chemical attack. These include: (a) constant wearing of full protection unless under cover; (b) wearing full protection in shifts to acclimate all troops and maintain some in full protection; (c) development of interim protection such as goggles and mosquito netting to catch agent droplets without imposing an appreciable heat load; (d) attachment of a face shield and neck protection on combat helmets to parallel protection developed for firemen by Natick Laboratories (Reference: DARCOM News, Vol. 6, No. 1, page 5); (e) development of an instantly deployable, helmet-mounted cape with temporary masking to provide cover and respiratory protection until full protection can be used (Reference: DF, SAREA-BL-C, Biomedical Laboratory, 9 May 1975, Subject: Proposal for ILIR Program), or (f) development of impermeable cooled uniforms (as under investigation at Natick Laboratories and in foreign countries).

26. Portions of the exercises described were observed by Major Percy E. Dunagin, Jr., or by Mr. Floyd B. Brinkley, and their comments are incorporated in the above observations of the OFT.

/ts/

MILLARD M. MERSHON
Pathobiology Branch
Experimental Medicine Division
Biomedical Laboratory

APPENDIX J

ESTIMATE OF SPAL RELIABILITY IN OBT

BY

John Dickie, III

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CHEMICAL SYSTEMS LABORATORY
MUNITIONS DIVISION
APPLICATIONS BRANCH

DRDAR-CLN-P

1 December 1977

MEMORANDUM FOR RECORD

SUBJECT: Estimate of SPAL Reliability in the SPAL OFT

1. Introduction

a. The TDLR for the Phase I Training System for Chemical Defense stipulates that, "The munition (filled) shall have a reliability of 0.80 minimum, where reliability is defined as the probability that the simulant agent container will launch on command and burst at a height between 6 and 25 meters, when emplaced to launch vertically at +5°. Since the munition is a completely expendable item, availability and maintainability are not issues." The Phase I TDLR was prepared with the US SPAL system, viz. UK SPAL hardware and US CAST1, in view.

b. An estimate of SPAL reliability in the SPAL OFT is given here. SPAL reliability in the TECOM DT and CSL tests is reported elsewhere.*

2. Procedures and Results

a. Data sources used in preparing the reliability estimate were:

(1) SPAL hardware, recovered following each SPAL attack.

(2) Long range and close up color motion pictures taken during the OFT. The long range camera with zoom lens was located at the exercise or trial control point, usually several hundred meters from the SPAL attacks. During the SPAL attacks, a close up camera was operated from the control vehicle, usually about 100 meters from the point of attack. Both cameras were operated at 24 frames per second.

b. Five trial exercises were conducted in the SPAL OFT. In four of these trials, a total of seven SPAL attacks were delivered. Five SPAL were used in each attack, for a total of 35 SPAL.

c. There was one SPAL misfire, i.e., failure of the bottle to launch and burst, and it occurred in Trial 2, Attack 1 (T2, A1). Subsequently, this SPAL was returned to bldg E3580, set up and fired. The bottle launched

*RAM Engineering Branch Report No. QAC-R S&R 77-13, November 1977, Reliability Assessment for SPAL.

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DRDAR-CLN-P

1 December 1977

SUBJECT: Estimate of SPAL Reliability in the SPAL OFT

and airburst at about 10 meters. In the OFT the misfire was probably caused by faulty hookup wiring. All other SPAL bottles (34) launched as evidenced by inspection of the launch tubes, all of which were recovered empty following each attack.

d. The bottle hardware fragments recovered after each attack are noted in Table 1. Each major bottle fragment was identifiable by a Projector Assembly Inventory Control Number (PA ICN) which had been marked on the bottom and near the neck of each bottle prior to use in the OFT. No intact bottles were recovered. Recovery of an identifiable bottle fragment is conclusive evidence that the bottle burst. As evidenced by recovered fragments, at least 22 of 34 bottles burst.

e. The film records were used to estimate heights of burst and for additional evidence that bursts had occurred. In terms of utility for this purpose, the films fall into four major classes:

(1) Class A: The field of view includes all five SPAL, with all events from launch to airburst clearly visible.

(2) Class B: The field of view includes all five SPAL, however, the record does not begin until after launch has occurred and all airbursts are not clearly visible.

(3) Class C: The field of view includes the launch to airburst events of only 4 SPAL, however, as the film proceeds the cloud or signature from the remaining SPAL bottle drifts into the field of view. This signature is confirmation of burst. Its position relative to the ground and to other signature enables one to estimate the original height of burst.

(4) Class D: The film record contains launch to burst information for fewer than 4 SPAL, or no information.

f. A summary of film analyses is given in Table 2. In this analysis the SPAL are numbered 1 through 5 from left to right in the particular record. At least one satisfactory film record (Class A, B, or C) was found for each SPAL attack. No failures to burst were observed. Without resorting to complicated geometric plots, the film records cannot be used to obtain precise estimates of height of burst (HOB) for individual SPAL bottles. However, since the required HOB range is relatively broad, viz. 6 to 25 meters, classification of heights as too low, too high, or satisfactory by visual inspection using within field of view references such as the 10 meter distance between SPAL launch tubes is reasoned to be a satisfactory procedure. There was a good deal of variation in HOB in the OFT, but no observed burst was judged to be significantly higher than 25 meters. There were three definitely low bursts, and a few more judged to be bordering on low. Low bursts probably resulted from restrained bottle flight caused by failure of the

TABLE 1J
SPAL OFT Hardware Recovery

Trial/Attack	PA ICN Used	Bottle ICN Recovered
T1, A1	112 to 116	112, 114, 116
T1, A2	117 to 121	117, 119, 121
T2, A1	122 to 126	126 (misfire, 122, 123, 124, 125
T2, A2	127 to 131	127, 128, 130
T3, A1	132 to 136	132, 134, 135
T5, A1	137 to 141	137, 138, 141
T5, A2	142, 144 to 147	142, 144, 145

TOTAL Bottles Recovered: 22 of 34

TABLE 2J
Results of SPAL CFT Film Analysis

Trial/Attack	Long Range	Close Up
T1, A1	A, No. 5 burst on ground, r = 4/5	D
T1, A2	D	A, r = 5/5
T2, A1	A, No. 1 misfire, r = 4/5	D
T2, A2	C, r = 5/5	D
T3, A1	B, No. 3 burst low in brush, r = 4/5	D
T5, A1	B, r = 5/5	D
T5, A2	C, No. 2 burst low in brush, r = 4/5	A, No. 2 burst low in brush, r = 4/5

Notes: 1. A, B, C, or D denotes film class; see para 2e.
2. r denotes point reliability.

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DRDAR-CLN-P

1 December 1977

Subject: Estimate of SPAL Reliability in the SPAL OFT

Actuator lead wires to separate from the bottle and from the firing line. But, inefficient data was collected during the OFT to confirm this theory. This problem had been observed in previous CSL SPAL tests. Since the SPAL OFT the hookup procedure, as given in the US Operator's Manual, has been modified to reduce the likelihood of occurrence.

g. Even with HOB variation there was no adverse effect on SPAL performance in terms of downwind area coverage, as evidenced by the attack plots of what were judged to be highly successful direct SPAL attacks, viz. the four attacks in Trials 1 and 2, which were delivered under favorable, steady (predictable) winds. In these attacks 9 or 10 of the 10 trainees received agent contamination, at distances from 35 to 100 meters from the launch line, over areas as broad as 50 meters.

h. The point estimate of SPAL reliability for the entire OFT is 0.89. The point estimates of SPAL reliability in 4 of the 7 attacks are 0.8 (1 failure in each) and 1.0 (0 failures) in the remaining 3 attacks.

/ts/
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